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MARL IN ONTARIO

By
G. R. GUILLET

INDUSTRIAL MINERAL REPORT 28
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DEPARTMENT OF MINES

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By

G. R. GUILLET

INDUSTRIAL MINERAL REPORT 28

1969

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MAP
(Back pocket)

Map 2183 Ontario Marl Deposits. Scale 1 inch to 16 miles.

ABSTRACT

This report describes most of the known marl deposits in Ontario. Of the 107 occurrences mentioned, detailed sampling and analytical work was done on 45. In each case, sampling of the complete marl section, from top to bottom of the bed, was done with a piston-type peat sampler. In all, 73 samples were chemically analysed, and evaluated for brightness, oil absorption, particle size distribution, and shell content.

Marl is the product of biochemical precipitation induced by the process of photosynthesis in certain Green and Blue-green algae. In marl lakes these algae are so prolific as to give a most distinctive and attractive blue-green colour to the water.

Marl lakes typically occupy land-locked, spring-fed, basins close to bedrocks of limestone and dolomite. In Ontario, marl occurrences are most common in the southern part of the province, in areas of light to moderate drift, underlain by: Silurian dolomites of the Guelph and Amabel Formations; Ordovician limestones of the Trenton and Black River Groups; and Precambrian marble of the Grenville Series.

Marl deposits in Ontario are all post-glacial in age, and many are in an active stage of formation.

From 1889 to 1919 marl was used with clay in the manufacture of portland cement in Ontario. For much of this period it was used exclusively, in preference to limestone, in 14 cement plants. But for cement, as for most lime markets, marl is inferior to limestone because of the difficulties of drying the finely-sized particles and maintaining uniform composition. The most likely potential market for marl would seem to be in the field of industrial fillers.

MARL IN ONTARIO

By G.R. Guillet[1]

INTRODUCTION

Once the basis of a flourishing cement industry, marl has not been an important mineral commodity in Ontario for more than 50 years. However, curiosity about marl continues at a fairly high level, because of its striking appearance. The greatest potential for marl probably lies in the field of inorganic fillers, where its naturally fine particle size might make it competitive with other calcium carbonate fillers, especially where extreme whiteness is not required.

Marl invariably occurs in clear emerald-green lakes whose waters contrast most strikingly with the brown of black-coloured water of most Ontario lakes. Such lakes are a common sight for air travellers between Toronto and Ottawa, or across Grey county and the Bruce Peninsula.

Essentially an unconsolidated limestone, marl is a soft white material that forms the bed of certain small lakes and marshes. It is the product of a prolific algal life in spring-fed land-locked waters in areas of carbonate bedrock. Often mistaken for white clay, it has few clay properties, but in most respects is similar in appearance and application to finely-ground limestone.

OCCURRENCE AND COMPOSITION

"Marl" is a poorly-defined term that has been used to denote unconsolidated accumulations of shells, calcareous (limy) sands, calcareous clays and silts, and some glauconitic sediments, the only common characteristics being their unconsolidated nature and significant carbonate content. For purposes of this report the term "marl" will be restricted to

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[1] Geologist, Ontario Department of Mines, Parliament Buildings, Toronto 2. Manuscript received by The Director, Geological Branch, 17 January, 1969.

soft sediments having a total content of calcium and magnesium carbonates of 50 percent or greater. Calcareous clays or silts will thus contain less than 50 percent total carbonate. Most Ontario clays are calcareous and, like marl, will effervesce in acid. However, the difference in carbonate content is usually considerable, and because of the low plasticity and low density of marl, little difficulty is experienced in distinguishing them in the field.

Unfortunately, marl deposits are not known in Ontario to consist entirely of calcium carbonate or to possess extreme whiteness. Such would be the ideal condition for industrial utilization. Instead, marl deposits normally contain appreciable quantities of organic matter, clay, and fine sand.

Marl deposits in Ontario are geologically very young, having been formed only since the retreat of the glacial ice. Marl deposits were undoubtedly formed in pre-glacial times but were swept away by the scouring action of the subsequent ice.

The history of a marl bed began with a suitable depression on the post-glacial surface, the basin containing spring water having a relatively high calcium content. Suitable depressions were usually found in areas of carbonate bedrock having a thin cover of glacial overburden. The basin was normally walled by bedrock ridges in Precambrian terrains, but in Paleozoic areas more often by glacial debris.

With a restricted outlet - in many cases no outlet - calcium content of the cool lake waters tended to increase through evaporation, and newly-formed marl was not widely dispersed. Such an environment encouraged a prolific growth of lime-secreting organisms, among which some of the blue-green algae, and the green alga Chara, predominate. These microscopic plankton-like forms are responsible for the striking colour and clarity of the water, as well as the bulk of the marl. Also common are larger shelled animals of the snail (gastropod) and clam (pelecypod) genera, and occasional small clam-like molluscs of the ostracod family.

The process of marl formation by algae is largely precipitation. Lime is present in the water principally as calcium bicarbonate, a more soluble form than the carbonate, and is held there by the pressure of carbon dioxide dissolved in the water. In the process of growth by photosynthesis, all plants require carbon dioxide, water, light, and chlorophyll. Living marl-producing algae are tinted green or

blue-green as a result of their chlorophyll content, and they obtain their carbon dioxide requirements from the lake waters, so releasing calcium bicarbonate which immediately dissociates thus:

$$Ca(HCO_3)_2 \longrightarrow CO_2 + H_2O + CaCO_3$$

In this process calcium carbonate is necessarily produced, and because of its low solubility is precipitated rather than taken into solution. Under quiet water conditions the fine $CaCO_3$ particles sink, and the soft earthy deposits we call "marl" gradually accumulate.

Some marl may also be produced by purely chemical precipitation. Cold groundwaters percolating through carbonate bedrocks become heavily charged with lime held in solution as calcium bicarbonate by dissolved carbon dioxide. On reaching the lake, higher temperatures and increased agitation contribute to a loss of carbon dioxide, which favours precipitation of calcium carbonate. A further source of lime is the shell debris contributed by fresh-water molluscs that abound in most marl lakes. However, the deposition of calcium carbonate shells is of secondary importance compared to precipitation by algae.

The complete history of a marl deposit involves a lake-pond-muskeg sequence. In terms of geological time the rate of filling of a marl lake is extremely fast. Land first appeared through the melting Wisconsinan glacier in southwestern Ontario 14,000 years ago, in the Toronto region about 12,000 years ago, and at North Bay about 10,000 years ago. Marl deposits in central and eastern Ontario have therefore not had more than about 10,000 years to accumulate. Pollen studies on a number of gyttja (organic ooze) samples taken below the marl beds indicated maximum ages for the marl in the range 5,000 to 9,000 years (R. Mott, GSC Pleistocene Palynology Lab., personal communication). P.F. Karrow (1967, p.46) mentions a marl-filled bog near Toronto, pollen from which was estimated to be 7,000-8,000 years old.

Marl usually is deposited directly on sand or stoneless clay, more rarely organic ooze or bedrock. Wave action helps contribute to accumulation of marl as a shore fringe first, followed by gradual filling of the central basin. Low shallow-water plants of the sedge and sphagnum type gradually encroach on the shallow marl fringe. As filling continues, bog conditions become predominant, followed in turn by the mature stage of tamarack-spruce-birch.

Most Ontario marl occurrences are in an active stage of

marl accumulation, and are characterized by a prominent shore fringe of marl. This fringe can vary up to several hundred feet in breadth, measured from the muskeg shore, in many places extending also much further inland beneath the open bog. The surface of the marl fringe is flat and almost level beneath 1-3 feet of water. At the deep-water edge it shelves steeply, sometimes abruptly, into the central lake basin.

An interesting feature of open, wind-swept, marl lakes is the development of "marl bars". These are steep-sided, angular, masses of marl lying just below the surface, their shape and distribution reflecting the lake currents. Such currents are mostly wind-generated. One would hardly expect such flocculent, low density, material to be capable of standing in steep-sided banks. However, in physical properties and mode of formation these features can probably be likened to the accumulation of snow in drifts.

Exposed marl on the shallow fringes and bars is strikingly white. Except for scattered yellow-white snail shells these areas are not sites of deposition, organic or inorganic. A tall, dark green, cane-like reed, extending 2-4 feet above the water, is frequently found sparsely dispersed in shallow marl areas.

ORGANIC LIFE

A limited variety of organic life finds the high-lime environment of the marl lake suitable for prolific growth. Most important are a number of primitive unicellular algae, which are largely responsible for the occurrence of the marl and the colour of the marl waters. A number of molluscs are also common, but although they contribute their calcareous shells to the marl they are seldom prolific enough to produce "shell marl". Pollen, plus finely divided leaf and pine needle debris, and the remains of near-shore aquatic plants, is always present and often sufficiently common to colour the marl. All organic remains found in Ontario marls are from living species, not fossils.

Algae

Algae are the simplest members of the plant kingdom, many of which are little changed from ancestral forms that

were the primitive forerunners of all organic life. Of the many varieties known, algae of the Blue-green and Green classes have played the most significant part in the formation of marl deposits. These are microscopic, soft-bodied, unicellular or colonial, plant-like organisms that precipitate marl as an indirect product of photosynthesis; $CaCO_3$ does not form a part of their cellular structures.

Blue-green algae

Blue-green algae are single-celled primitive plant forms that comprise Class Cyanophyceae of the Division Schizophyta. They live individually or in loose chains or colonies, usually freely-suspended in the water. As a group they are by far the most important factor in the precipitation of marl. Their soft microscopic structures are not preserved in the marl, and their presence is only indicated by the blue-green colour which they impart to the water.

Green algae

Green algae are more highly developed than members of the Blue-green class. The most significant variety in marl lakes is Chara, a bottom-rooted plant of the stonewort family, belonging to Class Charophyceae of the Division Chlorophyta. Unlike the Blue-green algae, $CaCO_3$ precipitated by Chara often encrusts its stems and branches, resulting in longitudinally grooved fragments in the marl up to several millimetres in length. In studying the coarser fractions of Ontario marl samples the frequency of these recognizable fragments was recorded (see Appendix 1).

Diatoms

Several authors report that diatom skeletons are a significant part of the insoluble residue of marl. Fifty-two species have been identified in marl deposits of Alaska (R.M. Moxham and R.A. Eckhart, 1956, p.7). Diatoms comprise the largest class of algae, Class Bacillariophyceae of the Division Chrysophyta. They are particularly significant because they have microscopic skeletons of opaline silica that resist decay. Although no examinations for diatoms were made in Ontario marl samples, it is likely that they occur since they are known in other lakes in southern Ontario (D.F. Hewitt, 1967, p.34-44).

Snails (Gastropoda)

Snails are the most abundant of the shelled animals contributing calcareous material to the marl. Virtually all deposits contain at least a few snail shells, and in some deposits they are almost common enough to justify the name "shell marl". A few distinctive genera in common occurrence are described below.

Amnicola

Species of the genus Amnicola have low-spired shells. The opening or aperture of the shell is on the right-hand side when the aperture is facing the observer, and the shell is held vertically with the spire up. Species common in the marl lakes of Ontario are about ¼ inch long; they are smooth with faint growth lines.

Physa

Shells belonging to the genus Physa are less plentiful than those of other snails. They are smooth low-spired forms with the apertures on the left. The body whorl (ie. largest ring of the spiral) is conspicuously large, and its aperture is loop-shaped. Species found in Ontario marl are ¼ - 3/8 inches long.

Planorbis

Two species of the genus Planorbis can be distinguished in Ontario marl deposits. Both have the characteristic wheel-shaped coiled form. In one, the most common variety, the spire is sunken in the centre of both sides; growth lines are prominent and the whorls have a keel edge. The shell is about ¼ inch in diameter. The less common variety is larger - about 3/8 inch in diameter - and the growth lines are more regular. The whorls are smooth, not keel-edged, and the spiral is sunken in the centre on one side but level on the other. The aperture in both species is noticeably flared.

Graulus

At least one species of the genus Graulus is common in

marl lakes. This is a flattened, disc-shaped, wheel snail 1/8 - 1/4 inch in diameter. Another coiled snail, smaller and less flattened than the common one, may also belong to the genus Graulus; it is not easily seen without a low power hand lens.

Valvata

Species of the genus Valvata are small eccentrically-coiled snails. Keels or ridges on the outer surfaces of the whorls are usually conspicuous. The squat spire is blunt at the apex, and a cavity at the base of the spire is prominent in the bottom side. These snails are less than 1/4 inch in diameter.

Clams (Pelecypoda)

Mussels, or clam-like shells, are the only other important group of shells found in fresh water lakes. In marl deposits they are not nearly as important as the snails in abundance and variety. Clams have two valves, or shells, hinged together at one side. When the animal dies the two valves readily separate, so that the shells are usually found in halves rather than in their complete living forms. Two distinctive genera are described below.

Pisidium

Species of the genus Pisidium are known as "pill-clams". They are the smallest and also the most common clam-type shells in Ontario marl deposits. Shells of Pisidium are about 1/8 inch in diameter.

Sphaerium

Species of the genus Sphaerium are known as "finger-nail clams". They are thin, oval-shaped, shells with symmetrically located beaks and small hinge-teeth. Species found in marl range 3/8 - 3/4 inches in maximum dimension.

Ostracods (Ostracoda)

Ostracods are small lentil-shaped molluscs consisting of two valves hinged at the back like clams. They average about 1 millimetre in length. Ostracod shells are present in some deposits, and may go undetected in many others.

USES FOR MARL

Although marl has found little application in competition with other sources of calcium carbonate, it did enjoy a considerable market in portland cement manufacture, and were it economic, it could again substitute for many limestone uses. A useful reference to these uses will be found in The Limestone Industries of Ontario (D.F. Hewitt, 1960, p.14-16). For detailed information on most potential marl uses, the reader is referred to the AIME volume Industrial Minerals and Rocks (3rd edition, 1960), specifically chapters 8 - Carbonate Rocks, 9 - Cement Materials, 10 - Chalk and Whiting, 23 - Lime, 28 - Mineral Fillers, 29 - Mineral Pigments, and 42 - Secondary Fertilizer Minerals.

Portland Cement

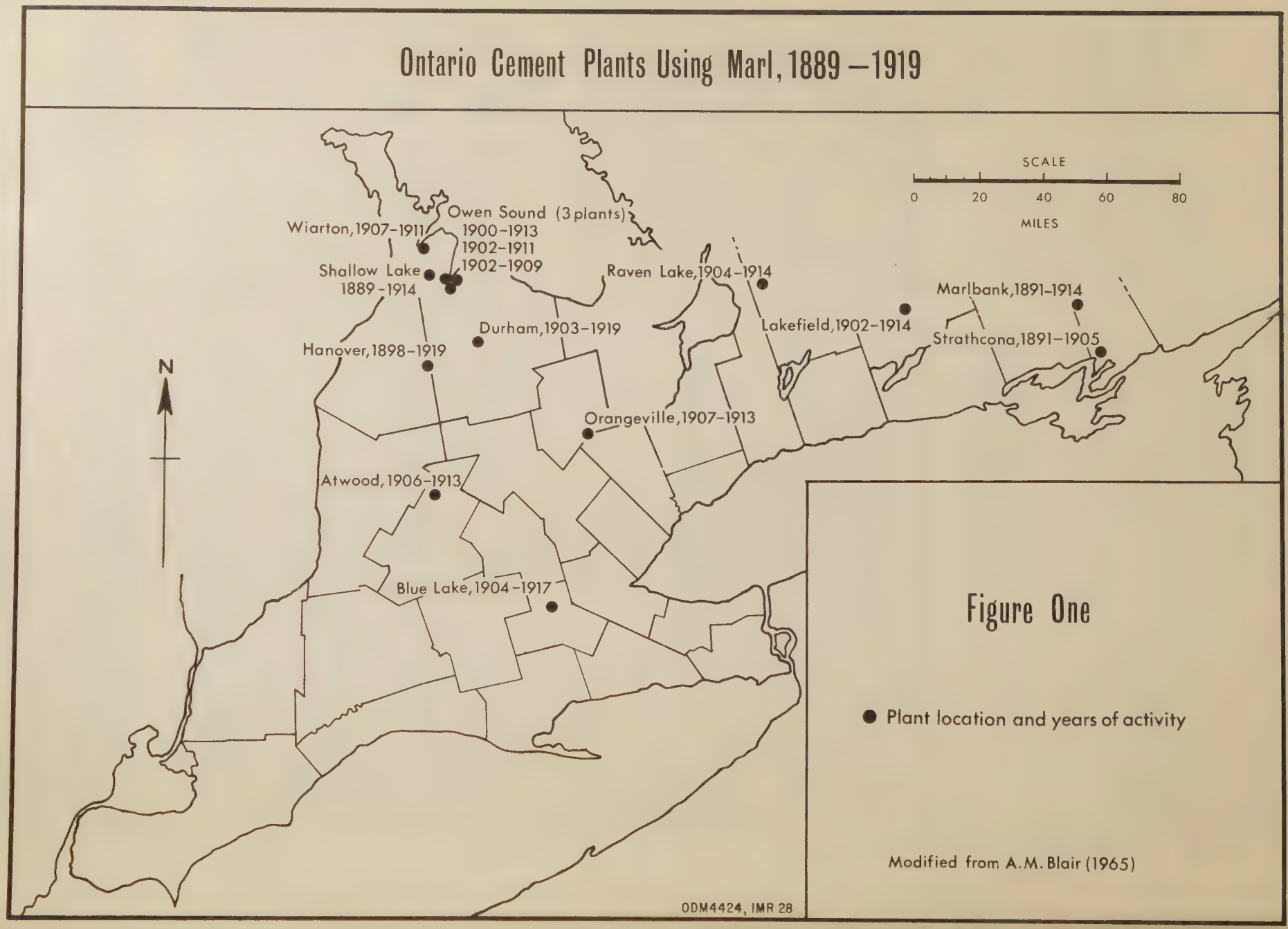
The history of marl production in Ontario is almost entirely related to its use in cement during the period 1889-1919 (see Table 1). Marl was the first source of lime to be used in Ontario's expanding portland cement industry. By 1907 portland cement had completely replaced natural hydraulic cement made from "cement rock" (A.M. Blair 1965, p.213). In that year 13 plants (see Figure 1) were producing cement from marl in southern Ontario. But the change from marl to limestone had already begun, with production from a new plant in Belleville in 1905, and by 1919 the use of marl had ceased in favour of limestone. A few of the marl plants were converted, but most were abandoned. Even before it had reached its peak, the decline of marl had been foreseen. The annual report of the Ontario Bureau of Mines for 1903 (T.W. Gibson 1903, p.33) stated:

"Hitherto all the Portland cement produced in Ontario has been made with shell marl as the ingredient supplying the necessary carbonate of lime. It is contended by some that

Table 1. Ontario Cement Producers Using Marl, 1889-1919

County	Marl Deposit	Company	Plant Location	Years of Activity
Brant	Blue Lake	Ontario Portland Cement Co.	Blue Lake	1904-1917
Bruce	Marl Lakes	Hanover Portland Cement Co.	Hanover	1898-1919
Grey	McNab Lake	The Sun Portland Cement Co.	Owen Sound	1902-1911
Grey	Shallow Lake	North American Chemical Mining, and Manufacturing Co.	Shallow Lake	1889-1892
		Owen Sound Portland Cement Co.		1892-1909
		Canada Cement Co. Ltd.		1909-1914
Grey	Shallow Lake marsh	Grey and Bruce Portland Cement Co.	Brookholm (Owen Sound)	1902-1909
Grey	Wiarton marsh	Colonial Portland Cement Co.	Wiarton	1907-1908
		Crown Portland Cement Co.		1909-1911
Grey	Wilder Lake	National Portland Cement Co.	Durham	1903-1919
Grey	Williams Lake	Georgian Bay Portland Cement Co. Ltd.	Owen Sound	1900-1901
		Imperial Cement Co.		1901-1913
Hastings	Dry Lake	English Portland Cement Co.	Marlbank	1891-1898*
		Beaver Cement Co.		1898-1900
		Canadian Portland Cement Co.		1900-1909
		Canada Cement Co. Ltd.		1909-1914
Hastings	Dry Lake	Rathburn and Co.	Strathcona	1891-1900
		Canadian Portland Cement Co.		1900-1905**
Peel	Orangeville beds	Superior Portland Cement Co.	Orangeville	1907-1913
Perth	Atwood marsh	Western Ontario Portland Cement Co.	Atwood	1906-1909
		Maple Leaf Portland Cement Co.		1909-1913
Peterborough	Buckley Lake	Lakefield Portland Cement Co.	Lakefield	1902-1909
		Canada Cement Co. Ltd.		1909-1914
Victoria	Raven Lake	Raven Lake Portland Cement Co.	Raven Lake	1904-1908
		Kirkfield Portland Cement Co.		1909-1914

* Plant inactive 1895-1898.
** Used clinker only from the Marlbank plant, 1904-1905.


Ontario Cement Plants Using Marl, 1889 – 1919
SCALE
0 20 40 60 80
MILES
N
Owen Sound (3 plants)
1900–1913
1902–1911
1902–1909
Wiarton, 1907–1911
Shallow Lake
1889–1914
Raven Lake, 1904–1914
Marlbank, 1891–1914
Lakefield, 1902–1914
Strathcona, 1891–1905
Durham, 1903–1919
Hanover, 1898–1919
Orangeville, 1907–1913
Atwood, 1906–1913
Blue Lake, 1904–1917
Figure One
● Plant location and years of activity
Modified from A.M. Blair (1965)
ODM4424, IMR 28

where solid limestone can be obtained of the required chemical composition, it can be substituted for marl with advantage in economy of manufacture. The marl as it is raised from the beds of shallow lakes, where it is usually found, contains a great deal of water which must be got rid of in the process of manufacture, and which adds to its weight and consequently to the expense of handling. Solid limestone on the other hand carries less moisture, and the crushing to which it requires to be subjected can be performed at less cost than is required for expelling the water from the marl."

D.F. Hewitt (1968, p.6-8) outlines the chemical requirements of cement raw materials. All but the most impure Ontario marls meet the necessary chemical specifications, but deposits of marl are less satisfactory than limestone because of their high water content, and because of the difficulties of quality control inherent in dredging operations. P. Gillespie (1905) gives a thorough description of the early cement industry in Ontario, including details on marl-handling equipment and the producing plants.

Industrial Fillers

Calcium carbonate is widely used as a filler in paper, paint, plastic, rubber, and linoleum, and for a great variety of minor uses. Known also as "whiting" and "whiting substitute", filler-grade calcium carbonate may be produced by chemical precipitation, and by grinding of chalk, calcite, limestone, and marble. Section 28 of Industrial Minerals and Rocks, by A.B. Cummins (1960, p.567-584), gives an extensive bibliography on the uses of fillers in various applications.

For filler use, physical properties are more important than chemical properties, and the most important single feature is whiteness, or brightness. Brightness of top-quality commercial calcium carbonate fillers is usually in the range 95-99, relative to a standard composed of magnesium carbonate having an arbitrary value of 100. Even low-grade products for putty and caulking compounds seldom have brightness values less than 90.

Particle sizes should be in the micron range (minus 325-mesh) for top-quality fillers, and have a narrow particle size distribution. ASTM Specification D1199 recognizes three grades based on fineness:

Grade I (Paint grade) - Essentially all finer than 15-20 microns; not more than 1 percent coarser than 325-mesh (44

microns).
Grade II (Filler grade) - Substantial amounts in the 10-44 micron range; not more than 15 percent coarser than 325-mesh (44 microns).
Grade III (Coarse or Putty Powder grade) - Fewer fines and substantial amounts of coarse particles; not more than 30 percent coarser than 325-mesh.

Abrasiveness, caused by oversize or unusually hard particles such as quartz, is particularly undesirable in papermaking and printing equipment.

Oil absorption is an important property of fillers. Oil absorption increases with fineness of particle size, and depends also very markedly on whether the filler was produced by precipitation or by grinding of the natural mineral. Chemically precipitated fillers (eg: artificial chalk, marl) usually have oil absorptions in the range 30-65; ground limestone, marble, and calcite, 5-16. Oil absorption is usually measured by the "Rub-out" method as detailed in ASTM Designation D281.

Chemical purity is, of course, also important. The calcium carbonate product should be free of impurities, such as clay or silt, and organic matter. For most uses a high-calcium product is preferred to ones containing appreciable amounts of the magnesium carbonate.

Table 2 gives some physical and chemical properties of typical commercial calcium carbonate fillers:

No. 1, "Precipitated Chalk", is artificially prepared by chemical precipitation.
No. 2, "Snowflake White", is a wet-ground calcite product.
No. 3, "Rambo White", is a dry-ground marble product.
No. 4, "Putty Filler", is a dry-ground marble dust.

Table 2 | Some Typical Calcium Carbonate Fillers

	1 Precipitated Chalk	2 Snowflake White	3 Rambo White	4 Putty Filler
Particle size: Range (microns)		1-20	1-50	80% minus 325-mesh
Mean (microns)	0.25	5	14	
Brightness	97	95	92-94	88-90
Oil absorption (Rub-out)	59	9-10	5-6	
Bulk specific gravity (lbs./cu. ft.)	20	50	65	80
Chemical analysis:				
$CaCO_3$	98.50	98.20	95.6	95.6
$MgCO_3$	1.70	1.10	3.5	3.5
Fe_2O_3	0.04	0.16	0.15	0.15
Insoluble		0.57	0.46	0.46

Paper

Calcium carbonate is second only to clay in the tonnage used in the paper industry. It improves whiteness, opacity, and printing ink receptivity at low cost. Only high-quality fillers can be used; abrasiveness due to coarse particles or hard impurities is particularly damaging to papermaking and printing equipment. A reasonably high oil absorption may be preferred in the filler because it permits faster printing with oil-base inks.

The usual calcium carbonate contents of various types of paper are (A.M. Brooks 1958, p.33):

Magazine paper	23-28 percent
Book	12 percent
Cigarette	20 percent
Newsprint	4-6 percent

Marl from the Dry Lake deposit at Marlbank was used as a paper filler by the Ontario Paper Company for a short time during World War II. According to A.M. Brooks (1958, p.12) a reasonably white paper cannot be expected when marl is used in substantial amount.

Paint

Fillers are usually referred to as "pigments" or "extender pigments" in the paint industry. Calcium carbonate is an extender pigment because its primary function is not for colour but for its bulking value. It is widely used in paint because of its high brightness, low specific gravity, and low cost (C.R. Martens 1964, p.75).

Paints require high-quality fillers. Because the oil absorption value of a filler is an indication of the viscosity of the resulting paint, fillers may be chosen to effect a desired paint viscosity. Other properties of importance in selecting a calcium carbonate product for any particular paint formulation are the relative wetting values for linseed oil and water, and its degree of reactivity in an acid medium (R.L. McCleary, 1946, p.1-3).

Rubber

Calcium carbonate fillers are used particularly as diluents in low cost rubber materials. Although chemical

specifications are high (often not less than 98 percent $CaCO_3$, and critical limits on copper, manganese, iron, alumina, and silica), physical properties are not as demanding as for paint and paper. In particular, brightness is not so critical except for high-quality light-coloured rubber. Many low-cost rubbers can tolerate off-white fillers, and in these cases marl may be satisfactory.

Putty

Putty normally consists of 85 percent calcium carbonate filler and 15 percent linseed oil. However, because of higher oil absorptions precipitated calcium carbonates and marl may require more oil than ground mineral products. ASTM Specification D317 requires the filler to be free from grit, virtually free from acid, and to contain a minimum of 95 percent $CaCO_3$. Specification 1-GP-6-1946 of the Canadian Government Purchasing Standards Committee requires that the alkalinity should not exceed 0.1 percent, volatile matter at 105°C should not exceed 1 percent, and particle size should not be coarser than 3 percent on a 200-mesh (74 micron) sieve (W.W. Key, 1960, p.239). These specifications do not restrict fine particle sizes or colour, but the high oil absorption of marl may be detrimental.

Pesticides

Calcium carbonate fillers are sometimes used as carriers or diluents in sprays or dusts bearing toxic substances for pest control. The filler may comprise 80-99 percent of the total pesticide formulation. Desirable properties of a filler depend on the individual formulation and the local conditions in which it will be used. It is therefore only possible to indicate a few general guidelines.

For use in sprays, particle size should not greatly exceed 10 microns; for dusts 40-50 microns is preferred. For aerial crop-dusting, high density is preferred to minimize drift. High absorptive and adsorptive characteristics are necessary to retain the free-flowing character of dusts. Abrasiveness should be low. In addition, each formulation must be individually assessed for compatability of filler and toxicant, adhesiveness to plant leaves, wettability of filler for sprays, etc. (W.W. Key, 1965, p.2-6).

Largely because of their favourable natural particle

sizes, marls might find application in some pesticides.

Land Fertilizer

Marl can be used to neutralize acid soils, and in Quebec this is the only use to which appreciable quantities of marl have been put (G.W. Waddington, 1950, p.1). However, the practice has been small and local in nature because both specifications and price are low. Specifications for ground agricultural limestone require a minimum of 85 percent $CaCO_3$, and maximum particle sizes well above that of marl, so that most marls should be well-suited for this use. In Quebec, farmers usually look after their own needs, digging the marl in winter with improvised equipment, and spreading it on the land at the rate of 2-3 cubic yards per acre.

Because of the preponderance of limy soils in Ontario, especially in the vicinity of marl deposits, the need for agricultural limestone is not great. Of the 13 million acres of suitable agricultural land in southern Ontario, about ¾ million acres could be improved by lime fertilization (D.W. Hoffman et al., 1964, p.7-8).

Road Stabilization

The use of ground limestone or hydrated lime for soil stabilization is particularly effective in reducing the plasticity, shrinkage, and swelling characteristics of clay-soil road bases. The improved characteristics are due to a combination of reduced acidity, agglomeration of fine clay particles, and minor cementing action believed to be pozzolanic. Road stabilization is widely practiced in the southern states of the U.S.A. and in western Canada, particularly because of the frequency of swelling bentonite-type clays.

Clay soils in Ontario are generally limy, and contain the non-swelling clay mineral illite, and therefore do not display the same degree of instability. However, lime stabilization of Ontario roads is increasing. The Ontario Hydro is promoting the use of a granular material composed of lime and fly ash that contributes useful pozzolanic characteristics in base course road construction.

Burned Lime

Many uses for limestone depend on its availability in

lump form so that it can be burned in commercial lime kilns. The burning of limestone (essentially $CaCO_3$) produces lime (CaO) through the expulsion of carbon dioxide (CO_2) gas. Numerous applications for the white lime product are found particularly in the chemical and construction industries. Commercial lime kilns are of two main types: Vertical stack kilns requiring limestone in lumps 3-9 inches; rotary kilns requiring ¼-½ inch limestone. Finer sizes are lost with the stack gases (D.F. Hewitt 1960, p.6).

Although the economics are doubtful to-day, it was apparently common practice a century ago to burn marl briquettes into lime. In his Geology of Canada, W.E. Logan (1863, p.763) says:

"When calcined, marl yields a nearly pure and very white lime, well adapted for mortar and for other uses. In many parts of Vermont large quantities of lime are thus manufactured. The marl is moulded into shapes like bricks, which are dried and burned in a kiln."

HISTORY OF MARL PRODUCTION

The history of marl production in Ontario started with its use in portland cement in 1889. No doubt there was minor local use before this date for burned lime (marl briquettes), as was common in parts of northeastern U.S.A., and for land fertilizer, but these went unrecorded. For some years marl was the only source of lime used for portland cement in Ontario, and 14 plants were active (see Figure 1 and Table 1). But by 1919, limestone had completely replaced marl in the cement industry, and only small short-lived marl operations have since been recorded.

Marl from a deposit near Kilbride in Halton county was being used in 1921 in the manufacture of concrete sewer pipe and culvert tile by W.O. Morse.

Since the decline of its use in cement, the most elaborate attempt at production was by White Valley Chemicals Limited in 1939-40. A small plant to produce filler grades was built at the deposit north of Bobcaygeon in Peterborough county, but sales of only 900 tons are recorded.

During the war years when English chalk was difficult to

obtain, the Ontario Paper Company used marl from the south end of Dry Lake and the marsh north of Marlbank as a substitute paper filler. Although there is no record of its performance in this case, A.M. Brooks (1958, p.12) states generally that a reasonably white paper cannot be expected if substantial amounts of marl are used.

In 1957 Gerard Senecal removed 71 cubic yards of marl from a deposit in Thorneloe township southwest of Timmins, but only test shipments were made.

MINING AND PROCESSING

The excavation of marl for portland cement manufacture was usually accomplished by clam-shell, dragline, or suction dredging. Although sometimes mounted on rail, the equipment was usually floated on a barge, and the marl conveyed to shore through a flexible pipeline. These methods were poorly suited for selective mining, and variation in marl quality was a problem that hampered the industry.

Some beneficiation is possible using spiral classifiers and settling tanks with the marl in slurry form, and to this extent suction dredging, or pumping, may be advantageous. Colour of the marl can be improved by removal of the more buoyant vegetative matter, and grit content can be lowered by elimination of coarse sand grains. Final sizing of dried marl using air classifiers should be effective in producing closely sized products in the micron ranges.

Drying of marl is the most difficult aspect of marl production, because of the very fine particle sizes. Two methods were used in the cement plants: The most common was to feed the clay-marl slurry directly to a rotary kiln, or one of several types of stationary kiln; the other involved partial drying of the slurry, followed by pugging and extrusion of bricks, which were racked for drying before burning to clinker in the kiln. The White Valley Chemical plant north of Bobcaygeon made use of natural drainage of stockpiled marl, plus steam-heated vibrating tables and banks of infra-red lights.

Recent advances in drying and handling of fine grained materials encourage the possibility of spray drying or fluid bed drying for marl. Both methods use oil or gas-heated air

in an enclosed chamber to effect almost instantaneous evaporation of atomized slurry. The slurry is introduced as a spray in the first method; in the second, the heated air is pulled through a bed of the slurry, creating the turbulence necessary for effective drying.

There is no established practice for marl handling and beneficiation, and the successful design of a plant and process may well be the key to production of acceptable marl products. For the filler industries it would seem that a satisfactory process must involve beneficiation by centrifugal or gravity methods. The aims particularly must be to improve whiteness and remove grit.

PRICES AND MARKETING

The easiest way to determine the acceptability of a marl product for filler markets will be by consultation with local distributors of pigments and chemicals. These are supply houses that handle a great variety of mineral products for the chemical and filler industries. Many of these products are imported from great distances at high cost, and suppliers are therefore interested in local materials, particularly if available at lower cost without sacrifice in quality. Local distributors are the only people who can provide precise information on consumption and prices for products of various qualities in the local market area.

Mineral statistics for Canada show a small production of marl each year for agricultural purposes. The production in 1965 amounted to 175,000 tons valued at $265,923, but information on the source of this production is not available (D.H. Stonehouse, 1967, p.2).

Imports and consumption of calcium carbonate fillers (whiting) in Canada are shown in Table 3 as given by Stonehouse (1968, p.5), but no precise information is available on domestic production.

Prices in the United States for various grades of calcium carbonate fillers, as given in the Oil, Paint and Drug Reporter for December 2, 1968, are reproduced in Table 4. Prices refer to one ton of bagged material in carload lots at the producing plant.

Table 3 | Imports and Consumption of Whiting in Canada

	Tons	Dollars
Imports, 1967:		
United States	11,821	350,000
Britain	1,534	29,000
France	802	11,000
West Germany	20	2,000
Total	14,177	392,000
Consumption, 1966:		
Paper	33,057	
Linoleum, oilcloth, floor tile	30,627	
Rubber	20,801	
Paint, varnish	16,618	
Roofing	15,780	
Gypsum products	11,357	
Asbestos products	10,374	
Foundry	3,035	
Fertilizers, poultry feed	1,299	
Miscellaneous chemicals	738	
Other uses	8,779	
Total	152,465	

Table 4 | Prices for Various Calcium Carbonate Fillers

	Price per ton
Natural mineral:	
Dry ground, 325-mesh	$ 13.50-19.00
Water ground, 10-30 microns	$ 22.00-23.00
Water ground, ½-10 microns	$ 35.00-37.00
Chalk:	
Whiting, 325-mesh	$ 36.00-38.00
Precipitated:	
Dense	$ 30.00-38.50
Surface treated	$ 42.00-44.00
Ultrafine	$117.50-167.50

MARL TESTING

Sampling

The sampling of a marl deposit can be carried out rapidly and effectively using inexpensive equipment. A simple piston-type peat sampler, of which several similar models are manufactured, is actually better suited for sampling marl than it is for peat. The sampler used consisted of a 15-inch stainless steel sample tube, 7/8-inch in outside diameter and 3/4-inch in inside diameter. It yields a core sample 10 inches long and 3/4-inch in diameter.

The sample tube is attached to successive 4-foot steel rods, 1/4-inch in diameter, via brass couplings. A T-handle is fastened to the end of the column. In use, the sampler is lowered to any desired depth, adding 4-foot extension rods as necessary. The sample tube is opened by retracting the rod column, so removing the piston from the sample chamber. A snap lock keeps the piston from re-entering the chamber when positive pressure is again applied to the column. The open sampler is lowered a further 10 inches, cutting a core of strata that is retained in the chamber on removal to surface.

It should be noted that in sampling horizontal strata it is not necessary to use precisely the same location in taking successive samples. Indeed, it was not possible to maintain an open drillhole in soft marl. It is only necessary to keep track of the depth, using the brass couplings as footage markers.

Samples are forced from the chamber by releasing the lock pin and pushing the piston back into the sample chamber. In this sampling program it was found convenient to use three stainless cake pans, 2" x 6" x 10", for collecting the samples. Each sample was always discharged into a clean empty pan, so that it could be examined before combining with previous sample material. Samples for analytical study were transferred to sealed plastic bags.

Most deposits were sampled in only one location, usually near the deep-water edge of the marl fringe so as to get a reasonably thick section. A broad, flat-bottomed, 8-foot aluminium rowboat was a satisfactory platform from which to work. Weighing only 56 pounds, it was easily carried on the roof of a car. A small drag-type anchor from each end kept the boat reasonably stationary during sampling.

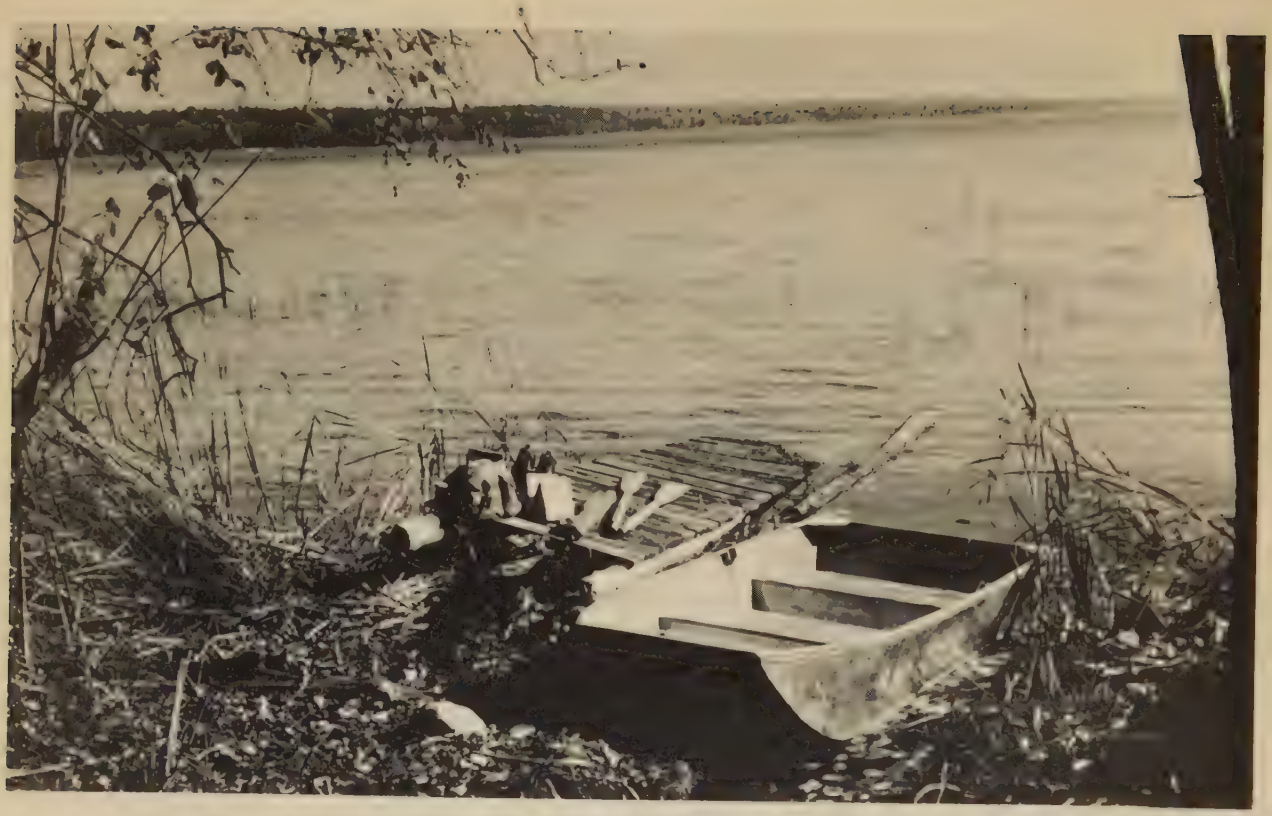


Photo 1 - Marl sampling equipment.

Photo 2 - The marl sampler.

Eight 4-foot steel rods gave the sampling equipment a capability of more than 30 feet. Although increasing density of the marl made sampling difficult below about 20 feet, there were only a few deposits where the bottom was not reached. Using the equipment described, the author had no difficulty carrying out the field program unassisted.

Field Observations

Aerial photographs are invaluable for marl studies. Not only can marl lakes often be recognized quickly, but the disposition of thick marl fringes and bars becomes immediately apparent. Unretouched prints on a scale of 1 inch to ¼-mile are preferred. Aerial mosaics sometimes have their lake areas blacked-out for greater contrast, so destroying any evidence of marl. Photographs covering all of Ontario are available for examination or purchase at the Department of Lands and Forests, Downsview, and the National Air Photo Library, Ottawa.

Using aerial photographs on a scale of 1 inch to ¼-mile, the best access to the marl lake, and the most likely area for favourable sampling, was determined. At the site, samples were taken continuously from the top of the marl bed, all measurements being referred to the water surface (ie. lake level). During sampling, a written log of the section was maintained, noting such features as depth of water and character of the material underlying the marl. Changes in the density, colour, texture, and organic content of the marl were particularly noted.

Laboratory Study

Results of laboratory studies are detailed in the Appendix. All the laboratory work was performed by the Laboratory Branch, Ontario Department of Mines.

Two lab samples were cut from each field sample as follows:

1. Exactly 200 grams of wet (as received) marl were dried slowly, weighed, and lightly pulverized in a mortar. Moisture content of the crude marl was determined, and the dried sample was used for particle size analysis.

2. 50-100 grams of wet marl were placed with a deflocculating agent in a dispersion cup for 3-5 minutes, then wet-

screened on a 100-mesh sieve. Oversize was dried and used for visual examination of shells and other organic matter. Undersize was suction-filtered in a Buchner funnel, dried at 80°C, lightly pulverized in a mortar, and used for chemical analysis, brightness, and oil absorption tests.

Moisture Content and the Calculation of Marl Reserves

The moisture content of marl in place is high, commonly 50-75 percent by weight of the crude marl. The fine particles of calcium carbonate remain dispersed, showing little tendency towards packing even at the base of the marl bed. This feature of marl was particularly noticed in sampling, where the density of the marl bed only on rare occasions prevented penetration of the sampler to its full depth. Yet in soft stoneless clay that often underlay the marl bed, the sampler could rarely penetrate more than a few inches.

The very large amount of water contained in a marl bed is a major factor in the economic evaluation of a marl operation. The cost of eliminating the water was undoubtedly a major reason for replacing the wet marl process for a dry limestone method of portland cement manufacture. Final drying of the very fine marl product was also certainly an important factor in the short life of the White Valley whiting operation near Bobcaygeon.

Calculation of the amount of dry marl contained in a given volume of the crude is based on specific gravity. Although the true specific gravity (ie. in solid form) of calcite is 2.7, the bulk specific gravity of finely-divided material is much less because of the air spaces between the grains. Thus the finer the particles the lower will be the apparent specific gravity. Several composite samples were made up by bulking together minus 100-mesh material from a number of individual samples, and their bulk densities were calculated from their weights and loose unpacked volumes. Apparent densities of 0.95 and 0.91 were obtained, equivalent to 60 and 57 pounds per cubic foot respectively.

A curve (Figure 2) was prepared so that the amount of dry marl available in a cubic yard of the wet crude could be quickly obtained, provided the moisture content of the crude was known. A bulk specific gravity value of 0.95 (60 lbs. per cubic foot) was used in the calculations. The higher of the two experimental values was taken as more likely to be

representative of the total (ie. including the plus 100-mesh fraction) marl content. Weight of 1 cubic yard of water was taken as 1,685 pounds, based on a density of 62.4 pounds per cubic foot. The relationship between moisture content of the crude and the amount of dry marl contained in it is almost a straight line because of the nearly equal densities of water (1.00) and loose dry marl (0.95). The curve (Figure 2) was drawn through points plotted for each 10 percent increment of moisture, as in Table 5.

Table 5 | Weight of Dry Marl at Various Crude Moisture Levels

Moisture percent	Apparent specific gravity	Pounds of dry marl available per cubic yard of crude
100	1.000	0
90	.995	168
80	.990	334
70	.985	499
60	.980	661
50	.975	822
40	.970	982
30	.965	1140
20	.960	1295
10	.955	1450
0	.950	1600

Particle Size Analysis

Using ASTM Standard D422, "Method for Grain-Size Analysis of Soils", the particle size distribution was determined for most of the marl samples. This is an hydrometer method, involving settling rates and Stokes' Law. Assuming the marl particles have the calcite structure, a specific gravity of 2.70 was used in the calculations.

Only the distribution of particles finer than 74 microns (200-mesh) was recorded by this method; standard sieve analyses would normally be used for coarser fractions. A graph of the hydrometer results was made, plotting particle diameters on a logarithmic scale against percentages passing these diameters on an arithmetic scale. Standard "Mechanical Analysis" graph paper is available for this purpose. After drawing a smooth curve through the plotted points, percentage passing any micron size can be read directly.

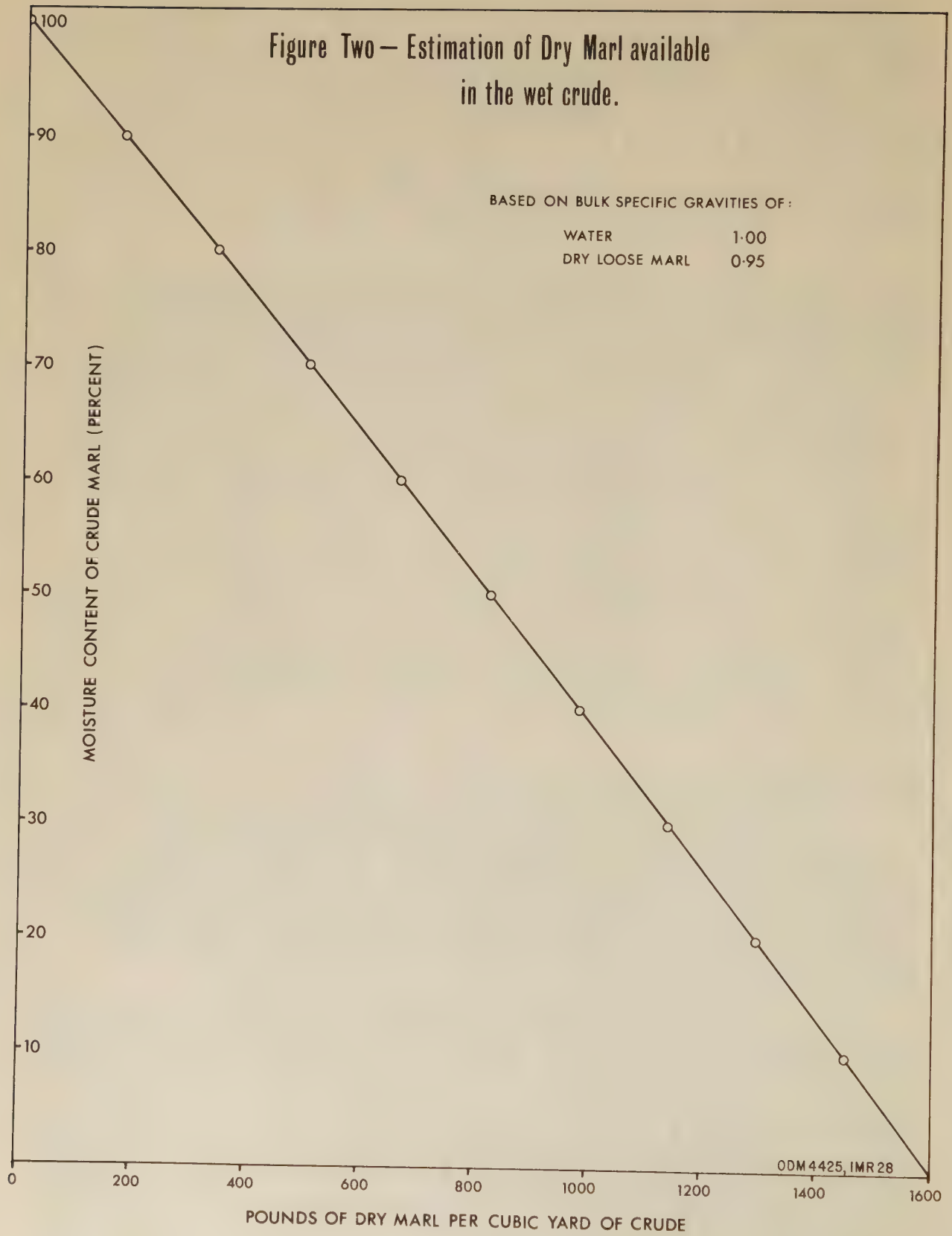


Figure Two – Estimation of Dry Marl available in the wet crude.
BASED ON BULK SPECIFIC GRAVITIES OF:
WATER 1·00
DRY LOOSE MARL 0·95
MOISTURE CONTENT OF CRUDE MARL (PERCENT)
100
90
80
70
60
50
40
30
20
10
0
200
400
600
800
1000
1200
1400
1600
POUNDS OF DRY MARL PER CUBIC YARD OF CRUDE
ODM 4425, IMR 28

Chemical Analyses

Chemical analyses were performed on a dried portion of the raw marl that passed a 100-mesh sieve. Thus, most of the moisture, shells, and coarse vegetative material were eliminated from the analytical sample. Chemical analysis for each sample included determinations for lime (CaO), magnesia (MgO), and iron (Fe_2O_3) by emission spectrography; insoluble, loss on ignition, and moisture by conventional wet analysis. $CaCO_3$ was calculated by multiplying CaO by 1.785. $MgCO_3$ was calculated by multiplying MgO by 2.09. Loss on ignition includes both CO_2 and vegetative carbon. "Insoluble" refers to the portion of the sample not dissolved by hydrochloric acid - mainly silica (SiO_2), alumina (Al_2O_3), and iron - and hence is a rapid means of indicating the proportions of carbonate minerals (soluble) and silicate minerals (insoluble) in limy rocks.

Brightness

Brightness, sometimes also called whiteness or reflectance, is the most important single property of industrial fillers. Marls are inclined to be off-white, in pale shades of grey, yellow, brown, and pink. Finely-divided vegetative matter is usually responsible for some of the colour. The best marls have natural brightness values in the 70's; these can usually be readily beneficiated to the 80's by removal of some organic carbon.

In the present testwork, brightness measurements were made on the same dried minus 100-mesh samples used for chemical analyses. A Beckman DU spectrophotometer with reflectance attachment was used. Slit setting was 0.30 millimetres, and wavelength 589 millimicrons. Measurements were made relative to a magnesium carbonate standard having a brightness of 100. Since readings taken on marl briquettes were not essentially different from those taken on the loose powders, all values are reported for marl in its natural powder form.

Oil Absorption

Oil absorption is an important property in the evaluation of a paint filler. The oil absorption value is determined by adding linseed oil dropwise to a weighed amount of dry marl until the mixture forms a paste. The same minus 100-mesh

samples, as were used for chemical analyses and brightness, were used in the oil absorption tests. The spatula rub-out method as detailed in ASTM Standard D 281, "Method of Test of Oil Absorption of Pigments by Spatula Rub-Out," was used. Values are reported as the number of pounds of oil required to wet 100 pounds of marl.

Visual Examination

The coarse (plus 100-mesh) fractions of the marl samples were visually examined, using a low-power binocular microscope where necessary, to determine the amount of fibrous organic matter, and the frequency of various fresh-water shells. A limited variety of small molluscs made it practical to estimate the abundance of each genus for each sample. Identifications were based on descriptions in field guides to fresh-water plants and animals, of which a number of popular editions are available.

ONTARIO MARL DEPOSITS

Marl deposits in Ontario are notably related to bedrock. Spring waters percolating through limy bedrocks have been enriched with dissolved calcium bicarbonate, from which marl is later precipitated by biochemical processes. In Ontario the most common bedrock environments are the Paleozoic limestone and dolomite formations of southern Ontario. Of these the Guelph-Lockport-Amabel Formations of south-central Ontario, and the Trenton and Black River Groups of southeastern Ontario are favoured. In general, deposits of marl overlying the Silurian dolomites (Guelph-Lockport-Amabel Formations) are less pure than those overlying the Ordovician limestones (Trenton and Black River Groups). Dolomitic and calcitic Grenville marbles of southeastern Ontario are also common bedrocks for good-quality marl.

Calcareous glacial drift is taken to be the ultimate origin of the calcium carbonate in the marl deposits of Michigan and Ohio (C.F. Clausen 1960, p.210) and Minnesota (C.R. Stauffer and G.A. Thiel 1933, p.104-105), but only the Chalk Lake deposit in the Oak Ridges moraine in Ontario county appears to be so related in Ontario.

Descriptions of 107 marl occurrences are contained in the following section. Of these, new analytical data is

presented for 73 samples taken from 45 marl deposits. Each marl occurrence is numbered to correspond to its location on Map 2183 in the back pocket of this report. The list of occurrences is as complete as the author was able to make it, based on his own field observations and a search of the literature. However, there are certainly other deposits, particularly in the southeastern counties of Hastings, Frontenac, and Renfrew.

BRANT COUNTY

(1) Blue Lake, South Dumfries Township

Blue Lake is located in lot 1 of the first concession east of the Grand River, in South Dumfries township, Brant county. It is 4 miles northeast of Paris and 4 miles west of St. George. The lake is an excellent example of a worked-out and rehabilitated deposit. It is only accessible by private roads to two homes located on opposite shores near the west end.

Marl was dredged from Blue Lake by The Ontario Portland Cement Company from 1904 to 1917. It was used with clay in the manufacture of cement in a plant located on the south shore. The operation is described by Gillespie (1905, p.154).

Blue Lake occupies an area of 20 acres, but the marl underlying its waters has been largely removed. A further 15 acres of marsh west of the lake may be underlain by marl.

Shells are common in the marl. Several species of gastropod are particularly common. Fragments of the alga Chara are abundant. The deposit lies close to the contact between the Guelph Dolomite and shaly dolomite of the Salina Formation.

Although there appears to be little marl remaining on the lake bottom, a sample taken by the writer was of good quality. However, the marl has been much disturbed and may be contaminated in some places. A 3-foot section analysed 90.0 percent $CaCO_3$, 3.5 percent $MgCO_3$, 0.11 percent Fe_2O_3, and 1.82 percent insoluble. The dry powder is buff-cream in colour with a moderate brightness. Oil absorption is low. Natural grain size is 69 percent finer than 325 mesh, 33 percent finer than 10 micron. The crude marl contains 45.0 percent water; 900 pounds of dry marl can be obtained from one cubic yard of the crude.

The lake is deep, and it was not possible to find an undisturbed section of marl at a moderate depth. A disturbed section near shore at the west end of the main lake is described in Section 1. Detailed results of testwork on sample M55 are given in the Appendix.

Section 1 | Blue Lake

Depth below water (feet)	Description	Sample No.
0 - 1	Water	
1 - 4	Marl: Pale brown; soft; shells common; minor organic material.	
4 - 7	Marl: Cream-grey; moderately dense; gritty; fibrous organic matter scarce.	M55
7 +	Sand and gravel.	

BRUCE COUNTY

(2) Burford Lake, Albemarle Township

Burford Lake occupies a large area in the south-central part of Albemarle township. Although marl may underlie the entire lake, it is probably best developed in a small bay at the south end that occupies parts of lots 26 and 27, concession IV. The south end of Burford Lake lies about 5 miles north of Wiarton. It can be reached by boat from the secondary road between lots 25 and 26; the road trends east from highway No. 6 to the water's edge, a distance of less than one mile.

The circular bay at the south end of Burford Lake occupies an area of 100 acres. The water is uniformly shallow and the shores are low and marshy. Elsewhere the lake is moderately deep and the shores in places are rocky. Occasional boulders and tree stumps project above the lake surface, and there are a few weed beds. Cottages occur at intervals except at the south end.

Shells occur in moderate amount; gastropods, pelecypods, and Chara debris are represented. Organic matter is scarce. Outcrops of Guelph-Amabel dolomite are common.

Burford Lake marl is of fair quality. A 7½-foot section analysed 84.0 percent $CaCO_3$, 3.5 percent $MgCO_3$, 0.24 percent Fe_2O_3, and 2.20 percent insoluble. The dry powder is pale grey with a moderate brightness, and oil absorption is moderate. The natural particle size is 84.5 percent finer than 325 mesh, 63 percent finer than 10 micron. Moisture content of the crude marl is 60.2 percent; 660 pounds of dry marl are contained in one cubic yard of the crude.

A section measured at the centre of the small south bay is reproduced as Section 2. Detailed analytical results for sample M48 are given in the Appendix.

Section 2 | Burford Lake

Depth below water (feet)	Description	Sample No.
0 - 3	Water.	
3 - 10½	Marl: Cream-grey; moderately dense; shells fairly common; organic matter scarce.	M48
10½ +	Bedrock: Dolomite.	

(3) Pearl Lake, Brant Township

Pearl Lake lies in lot 32, concessions VI and VII, Brant township, Bruce county. It is accessible by secondary roads, 4 miles north of Hanover. Numerous cottages are located along the east and northwest shores. The C.N. Railway parallels the main road north from Hanover ½-mile east of the lake.

Pearl Lake occupies an area of 25 acres. It is a deep narrow lake with sandy or gravelly shores. Only in the shore-fringe at the south end does marl underlie the lake at a shallow depth. Two small ponds to the west, and neighbouring Dankert Lake to the east, are probably also underlain by marl.

Both gastropod and pelecypod shells occur in moderate amount, and remains of the alga Chara are present. The content of fibrous organic material is moderately high. Bedrock in the area is shaly dolomite of the Salina Formation.

The marl of Pearl Lake is only of fair quality. A 19-foot section analysed 83.5 percent $CaCO_3$, 3.0 percent $MgCO_3$,

0.13 percent Fe_2O_3, and 0.96 percent insoluble. Colour of the dry powder is dark buff with a low brightness. Oil absorption is moderately high. The crude marl is 69.4 percent water; 510 pounds of dry marl could be extracted from one cubic yard of the crude.

The marl was tested at the edge of the shallow fringe at the south end of the lake, 50 feet offshore from the juncture of a small creek connecting the lake to a small pond to the west. Sampling became difficult at depth, but the sampler was still in marl at 22 feet. It is described in Section 3. Detailed analytical results for sample M22 are given in the Appendix.

Section 3 | Pearl Lake

Depth below water (feet)	Description	Sample No.
0 - 3	Water.	
3 - 22+	Marl: Buff to pale brown; moderately soft; Moderate content of organic material.	M22

(4) Marl Lakes, Brant Township

The Marl Lakes occupy part of lots 68-71, concession III N, and lot 32, concession IV, Brant township, Bruce county. They are located 1½ miles north of Hanover, and are readily accessible by road. The lakes are now extensively developed for cottages and can no longer be considered as sources of marl.

The Hanover Portland Cement Company commenced production in 1898 using marl dredged from these lakes. Dredging continued until World War I when the plant was converted to limestone. The plant, located on the Saugeen River at Hanover, is described by Gibson (1903, p.31) and Gillespie (1905, p.142-144).

The marl is also described by Gillespie (1905, p.143 and 183) who reports that the deposit comprised 150 acres of a depth of 16 feet. A sample analysed by the Provincial Assayer, A.G. Burrows, gave:

	Percent
$CaCO_3$	92.00
$MgCO_3$	4.74
SiO_2	0.58
Fe_2O_3	0.57
SO_3	0.52
Ignition loss	1.66

(5) Walkerton, Brant Township

W.E. Logan (1863, p.764) mentions a small deposit 2 miles west of Walkerton in lot 6, concession I N, Brant township, Bruce county. He reports that ".... marl occurs in a peaty meadow, beneath a foot of soil. It is two feet in thickness, and extends over seven acres."

(6) Hanover, Brant Township

On the southwest side of Hanover, in lot 70, concession I S, Brant township, Bruce county, W.E. Logan (1863, p.764) refers to marl ".... in the banks of a little stream, near its junction with the Saugeen, and has in some places a thickness of three feet."

(7) Carlsruhe, Carrick Township

A small occurrence 4 miles southwest of Hanover, and about one mile west of Carlsruhe, in lot 25, concession XV, Carrick township, Bruce county, is described by W.E. Logan (1863, p.764). The deposit ".... covers about six acres, and was found to have a depth of twenty-seven inches. It is very pure and white, and is covered with a thin layer of black mould, forming the soil of a meadow. Other deposits, estimated at forty acres in all, occur in the immediate neighbourhood."

CARLETON COUNTY

(8) MacKay Lake, Gloucester Township

A small deposit in the Eastview suburb of Ottawa is mentioned by G.C. Hoffmann (1894, p.23-24). The marl is said to underlie the east side of MacKay Lake in lots 1 and 2, Junction Gore of the township of Gloucester, Carleton county. The marl is 5 feet thick, yellowish-white in colour, and contains numerous shells and root fibres. It gave on analysis:

	Percent	
CaO	52.24	(equivalent to 93.29 percent
MgO	0.13	$CaCO_3$)
Fe_2O_3	0.09	
CO_2	41.16	
Insoluble	1.08	
Ignition loss	4.90	

DUFFERIN COUNTY

(9) Orangeville, East Garafraxa Township

The Orangeville marl beds in Caledon township, Peel county, extend into lot 1, concession B, East Garafraxa township, Dufferin county. R.W. Ells (1902, p.63) describes this portion of the deposit as ".... extending over at least 20 acres with a depth of six feet." The deposit is further described on pages 85-87 of this report.

FRONTENAC COUNTY

(10) Ardoch (Green) Lake, Clarendon Township

W.E. Logan (1863, p.765) mentions an occurrence of marl on lot 23, concession I, Clarendon township, Frontenac county. The deposit underlies the waters of Green Lake, near Ardoch,

15 miles northwest of Sharbot Lake.

(11) Judge Occurrence, Hinchinbrooke Township

W.D. Harding (1947, p.73) gives the following description:

"In 1942 a deposit of marl was discovered in a thickly wooded depression about 12 chains east of No. 38 highway, near the north boundary of lot 6, concession II, Hinchinbrooke township, on the farm of Richard Judge.

The marl was found when digging post-holes for a fence. The deposit lies beneath about 2 feet of black soil. The marl is known to extend in a north-south direction for at least 150 feet. The true size of the deposit, however, and the tonnage of marl available are unknown.

A sample of marl taken by the writer from this location at a depth of about 2½ feet was analysed by the Provincial Assayer with the following results:-

	Per cent.
Insoluble in HCl	0.90
Iron and alumina	.16
Lime (CaO)	50.86
Magnesia (MgO)	1.20
Loss on ignition	46.29
Total	99.41 "

(12) Knowlton Lake, Loughborough Township

Knowlton Lake is located in lot 1 in concession VII, lots 1 and 2 in concession VIII, and lots 2 and 3 in concession IX, Loughborough township, Frontenac county. It lies 4 miles north of Sydenham, and about 20 miles north of Kingston. Access to the lakeshore is possible only by a private farm lane midway along the west shore.

The marl of Knowlton Lake occurs in distinct shoals along the west shore. Near the mid-point a continuous marl

shoal occupies an area of 30 acres. Small scattered marl areas to the north and south may total a further 30 acres. Elsewhere the lake is deep.

Knowlton Lake marl contains a wide variety of gastropod and pelecypod shells. Chara debris is common, and ostracods are present. Organic matter is scarce. The east shore of the lake is granite, but Grenville marble and Paleozoic remnants of sandstone and limestone are not far distant. The Holleford meteorite crater is ½-mile distant on the west side.

Knowlton Lake marl is of good quality. A 14-feet section averaged 88.3 percent $CaCO_3$, 2.8 percent $MgCO_3$, 0.16 percent Fe_2O_3, and 0.98 percent insoluble. The dry powder is buff-cream in colour with a relatively good brightness. Oil absorption is high. Natural grain size averages 85 percent finer than 325 mesh, 63 percent finer than 10 micron. The crude marl is 60.6 percent water; 655 pounds of dry marl are contained in one cubic yard of the crude.

A section sampled 400 feet offshore in the north-central part of the largest marl shoal is described in Section 4. Detailed analytical results for samples M52 and M53 are given in the Appendix.

Section 4 | Knowlton Lake

Depth below water (feet)	Description		Sample No.
0 - 3	Water.		
3 - 10	Marl:	Buff, cream-grey in lower 3 feet; moderately dense; low content of shells; organic matter scarce.	M52
10 - 17	Marl:	Dark buff, pink in lower foot; dense; low to moderate content of shells; organic matter scarce.	M53
17 +	Clay:	Grey; dense; smooth; stoneless.	

(13) Loughborough Lake, Loughborough Township

Much of Loughborough Lake forms the boundary between

Loughborough and Storrington townships. The southwest part lies some 12 miles north of Kingston. Marl is common as a shore fringe at the narrows near the centre of the lake; also at the extreme southwest end. It was not sampled. This deposit, and others nearby, is mentioned by R.W. Ells (1902, p.63-64).

(14) Black Lake, Olden Township

An occurrence south of highway No. 7 near Sharbot Lake is mentioned by W.D. Harding (1947, p.72):

"The presence of marl in shallow water in the extreme southwestern bay of Black lake, on lots 14 and 15, concession X, Olden township, has been known to local residents for many years. When the location was visited by the writer in 1945, these lots were owned by Andrew MacPherson, of Olden township. The extent of the deposit, although not precisely ascertained, is believed to be small."

(15) MacPherson Occurrence, Olden Township

An occurrence of marl north of highway No. 7 near Sharbot Lake is described by W.D. Harding (1947, p.73) as follows:

"A deposit of marl covering an area more than a quarter of a mile long and from 200 to 500 feet wide is situated east of White lake, less than a quarter of a mile northwest of No. 7 highway, in a level wet meadow bordering the north side of a small creek on the farm of Andrew MacPherson, lot 17, concession X, Olden township. The deposit, which is known to be several feet deep, is covered with from 3 to 6 inches of dark humus. One foot below the surface the material is nearly white in colour. A sample obtained at 10 inches below the surface was analysed at the Provincial Assay Office. The results were as follows:-

	Per cent.
Insoluble (SiO_2 = 0.51)	0.88
Iron and alumina	.33
Lime (CaO)	52.39
Magnesia (MgO)	1.12
Carbon dioxide (CO_2)	42.35
Loss on ignition (less CO_2)	2.37
Total	99.44 "

(16) White Lake, Olden Township

Marl at White Lake, northwest of Sharbot Lake, is described by W.D. Harding (1947, p.72):

"The presence of marl in the southwest bay of White lake, lot 16, concession VII, Olden township, has been known to local residents for many years. The marl occurs in several places in shallow water beneath a few inches of mud. The depth and extent of the deposit were not determined. A sample of impure marl containing some organic material obtained at a depth of slightly less than one foot beneath the lake bottom was analysed at the Provincial Assay Office, and gave the following results:-

	Per cent.
Insoluble (SiO_2 = 0.68)	1.04
Iron and alumina	.04
Lime (CaO)	48.60
Magnesia (MgO)	1.30
Carbon dioxide (CO_2)	39.00
Loss on ignition (less CO_2)	9.12
Total	99.10 "

(17) Inverary Lake, Storrington Township

Inverary Lake occupies part of lot 22, concession II, and lots 22-25 concession III, Storrington township, Frontenac county, about 10 miles north of Kingston. According to B.C. Robson and C.R. Young (personal communication) the lake bed

contains good quality marl. The writer tested the lake bed at only one location, 100 feet offshore near the southwest end, and no marl was encountered. Beneath 1 foot of water a brown organic ooze continued to a depth of 20 feet, succeeded by grey stoneless clay.

(18) Leland Lake, Storrington Township

Leland Lake occupies parts of lots 25 and 26, concessions IV and V, Storrington township, Frontenac county. It lies about midway between the towns of Inverary and Battersea, about 15 miles north of Kingston. The lake is accessible by a public landing midway along the south shore.

Leland Lake occupies an area of 130 acres. The water is deep for the most part, and marl is only obvious in several narrow reefs and a narrow shore fringe. The lake lies very near the contact between Grenville granite and paragneiss and Trenton-Black River limestones.

A wide variety of gastropod shells are represented, and Chara debris is common. Organic matter is rather scarce.

Leland Lake marl is of very good quality. A 15-foot section averaged 90.1 percent $CaCO_3$, 1.9 percent $MgCO_3$, 0.07 percent Fe_2O_3, and 0.74 percent insoluble. The dry powder is cream coloured with a good brightness. Oil absorption is moderately high. The natural particle size averages 78 percent finer than 325 mesh, 56 percent finer than 10 micron. The crude marl is 61.5 percent water; 645 pounds of dry marl are contained in one cubic yard of the crude.

A section sampled near the centre of a marl reef extending from the south shore is given in Section 5. Detailed analytical results for samples M50 and M51 are given in the Appendix.

Section 5 | Leland Lake

Depth below water (feet)	Description		Sample No.
0 - 2	Water.		
2 - 11	Marl:	Pale brown or buff, pink in the bottom foot; moderately dense; occasional white shells; organic matter scarce.	M50
11 - 17	Marl:	Buff-cream, pink-brown in bottom few inches; moderately dense; shells scarce except at bottom; organic matter scarce.	M51
17 +	Clay:	Grey; soft; silty.	

GREY COUNTY

(19) Eugenia, Artemesia Township

G.C. Hoffmann (1894, p.29-30) describes a small deposit on lot 24, concession IX, Artemesia township, Grey county. If the location given is correct, the deposit lies just west of Eugenia Lake, 3 miles north of Flesherton.

The deposit is described as covering 12 acres to a depth of at least 7 feet. The yellowish-white marl contains a few shells and fine roots. The analysis is reproduced, in part, as follows:

	Percent
$CaCO_3$	87.02
MgO	0.73
Fe_2O_3	0.25
Insoluble	8.30
Ignition loss	3.30

(20) Allan Park Station, Bentinck Township

A small deposit, 3 miles east of Hanover and not far from

Allan Park Station on the CPR, is located in lot 26, concession I, Bentinck township, Grey county. The following description (W.E. Logan, 1863, p.764) does not make clear whether the deposit lies in the concession north or south of the Durham Road:

"On the twenty-sixth lot of the first range of Bentinck, a deposit of marl has been traced over eight or ten acres of low ground, which is covered with heavy timber. The marl is very solid and pure, and where examined was found to be four feet in thickness."

(21) Habermehl Lake, Bentinck Township

Habermehl Lake is located in lots 4 and 5, concession VII, Bentinck township, Grey county. It lies 5 miles north of Hanover, and is accessible at its east end by secondary roads. A branch of the C.N.R. passes west of the lake at a distance of about 1 mile. Several cottages are located on high sandy ground on the south shore.

Habermehl Lake occupies an area of 50 acres. Marl underlies the lake at a shallow depth on a broad fringe along the north and east shores. Low wooded ground to the northwest may also be underlain by marl.

Both pelecypod and gastropod shells are found in the marl in moderate amount. Chara debris is also present. Organic material, both finely-divided and fibrous varieties, is rather common. Shaly dolomite of the Salina Formation is the bedrock.

Marl of Habermehl Lake is of rather poor quality. A 14-foot section analysed 78.9 percent $CaCO_3$, 2.8 percent $MgCO_3$, 0.20 percent Fe_2O_3, and 1.84 percent insoluble. The dry powder is grey-buff in colour with a low brightness. Oil absorption is high. The crude marl is 72.2 percent water; 465 pounds of dry marl are contained in one cubic yard of the crude.

A section sampled midway between the shores on a marl reef in the east half of the lake is described in Section 6. Complete analytical results for sample M23 are given in the Appendix.

Section 6 | Habermehl Lake

Depth below water (feet)	Description	Sample No.
0 - 3	Water.	
3 - 6	Marl: Very soft.	
6 - 20	Marl: Pale grey-brown, medium brown in bottom 3 feet; soft; shells common; organic content moderately high.	M23
20 - 23	Gyttja: Brown-black; rubbery texture.	
23 - 26	Clay: Grey; stoneless; limy.	
26 +	Sand: Medium-grained.	

(22) Habermehl pond, Bentinck Township

A small marl pond was noted in lot 10, concession IX, Bentinck township, Grey county. The occurrence is 1½ miles northeast of Habermehl Lake, to which it is connected by Habermehl Creek. The concession road dips south to avoid the pond. Marl may also underlie the adjoining marsh.

(23) Louise Lake, Bentinck Township

Louise Lake consists of two parts separated by the boundary road between concessions XII and XIII. The north part occupies 20 acres in lot 22, concession XIII; the south part, 60 acres in lots 21 and 22, concession XII; all in Bentinck township, Grey county. The lake lies 10 miles northwest of Durham, and is accessible by secondary road, a distance of 6 miles from highway No. 6.

The north part of Louise Lake is deep. It was tested at the only shallow spot, off a marshy point in the east-central part of the lake. The south part of the lake was tested on a broad marshy fringe, where a creek from the north part joins open water of the south part. Only a soft organic ooze was found in the south part.

Both gastropod and pelecypod shells are present in marl of the north part, and Chara debris is common. Fibrous organic material is not abundant. Pelecypods are scattered through the dark organic ooze of the south part. Bedrock in the area is Amabel Dolomite.

Marl in the north part of Louise Lake is of good quality, but the reserves are small. A 10-foot section analysed 87.3 percent $CaCO_3$, 3.2 percent $MgCO_3$, 0.11 percent Fe_2O_3, and 0.64 percent insoluble. The dry powder is buff in colour and of moderate brightness. Oil absorption is very high. The natural particle size is 74 percent finer than 325 mesh; 55 percent finer than 10 micron. The crude marl is 68.6 percent water; one cubic yard of the crude contains 525 pounds of dry marl.

The organic ooze of the south part contains minor amounts of marl, clay, and sand, but is of no value as a marl source.

Sections sampled in the north and south parts of Louise Lake are described in Sections 7 and 8. Complete analytical results for samples M25 and M26 are given in the Appendix.

Section 7 | Louise Lake, North Part

Depth below water (feet)	Description	Sample No.
0 - 1	Water.	
1 - 11	Marl: Pale brown, becoming pink-brown at depth; soft to rather dense; minor shell content; fibrous organic material scarce.	M25
11 - 12½	Gyttja: Brown-black.	
12½ +	Sand.	

Section 8	Louise Lake, South Part

Depth below surface (feet)	Description	Sample No.
0 - 1	Peat: Dense; fibrous.	
1 - 10	Water: Fluid organic ooze.	
10 - 17½	Organic ooze: Brown; soft; jellatinous; shells scarce; minor marl, clay, sand.	M26
17½ +	Clay: Grey; soft; stoneless.	

(24) McCormick Lake, Bentinck Township

McCormick Lake straddles the mutual boundaries of lots 12 and 13, range IW, and lots 28 and 29, range IIW, in Bentinck township, Grey county. It is 2/3 mile west of highway No. 6, 5 miles north of Durham, and is accessible by secondary road from the highway.

McCormick Lake occupies an area of 35 acres. It is a shallow lake with gradually-rising treed shores. The lake bottom consists of very soft, brown, marly, organic ooze, containing a moderate number of gastropod shells. Bedrock in the area is Amabel Dolomite.

A partial analysis of the marly material showed 0.50 percent Fe_2O_3. The dry powder is dark grey with a very low brightness. Oil absorption is moderate. The crude material contains 92.4 percent water; 130 pounds of dry material could be extracted from one cubic yard of the crude. McCormick Lake is of no interest as a source of marl.

A section sampled near the centre of the lake is described in Section 9. Further analytical results for sample M24 are given in the Appendix.

Section 9	McCormick Lake	
Depth below water (feet)	Description	Sample No.
0 - 5	Water.	
5 - 10	Marly ooze: Brown; very soft.	
10 - 24	Marly ooze: Medium Brown; soft; moderate shell content; high content of finely-divided organic material.	M24
24 - 27+	Gyttja: Brown-black.	

(25) Wilder Lake, Egremont Township

Wilder Lake is located in lots 3-5, concessions XXI and XXII, Egremont township, Grey county. It lies 5 miles southeast of Durham, and 4 miles east of highway No. 6. The lake is accessible by secondary roads, and a public landing is located at the northwest end. The roadbed of an abandoned railway connecting the lake with a former cement plant at Durham lies along its west side.

Marl was dredged from Wilder Lake during the years 1903-1919 by the National Portland Cement Company. The marl was excavated by floating dredge and delivered to the plant at Durham by rail. The operation is described by Gillespie (1905, p.150 and 183).

Wilder Lake occupies an area of 100 acres, and except for a small part of the northwest end the marl has been mostly removed. The water is deep in the north half of the lake. In the southern part 2-5 feet of marl underlies 4-5 feet of water. The shores are not swampy, and the marl is probably limited to the lake bottom itself. Reserves of marl will be relatively small and may be contaminated as a result of the earlier workings.

Both gastropod and pelecypod shells are common; ostracods and Chara debris are also present. Fibrous organic material occurs only in trace amounts. Amabel Dolomite of Silurian age is the bedrock in the area.

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 3 - Wilder Lake, Egremont Tp., Grey Co.
The marl deposit was largely exhausted by the National Portland Cement Co., 1903-1919

Wilder Lake marl is of fair quality. A 7½-foot section at the northwest end of the lake analysed 85.7 percent $CaCO_3$, 2.4 percent $MgCO_3$, 0.11 percent Fe_2O_3, and 0.92 percent insoluble. The dry powder is pale grey with a low brightness. Oil absorption is moderate. Natural grain size is 76 percent finer than 325 mesh; 54 percent finer than 10 micron. The crude marl contains 64.5 percent water; 590 pounds of dry marl can be extracted from one cubic yard of the crude.

Throughout the southern half of the lake remnants of the marl beds 2-5 feet thick underlie 4-5 feet of water and overlie sand or bedrock. Although deeper water prevails at the north end, a marl shoal was tested from the end of the public wharf that extends 100 feet into the lake from the west side. The section is described in Section 10. Complete analytical results for sample M19 are given in the Appendix.

Section 10	Wilder Lake		
Depth below water (feet)		Description	Sample No.
0 - 4	Water.		
4 - 5	Marl:	Very soft; fluid.	
5 - 12½	Marl:	Pale grey; soft; uniform; moderate number of white or yellow shells; minor content of organic material.	M19
12½ - 14	Marl:	Dark brown; moderately dense; peaty; small white pelecypod and gastropod shells common.	
14 +	Sand:	Coarse-grained; limestone grains common.	

(26) Johnston Occurrence, Euphrasia Township

Correspondence in the files of the Ontario Department of Mines for 1924 refers to marl on lot 13, concession IX, Euphrasia township, Grey county. The occurrence is 12 miles southwest of Thornbury, on property then owned by Mr. R.C.

Johnston. It is described as underlying a marshy area of about 50 acres to a depth of 5 feet.

(27) Bells Lake, Glenelg Township

Bells Lake is located in lots 13 and 14, concessions XIV and XV, Glenelg township, Grey county. A small portion projects north into Holland township. The lake is situated between highways No. 6 and 10, and is accessible at its north end by secondary road. Markdale is 6 miles distant by road.

The area of the main body of the lake is 160 acres, but other connected ponds and extensive areas of low treed ground may extend the area underlain by marl considerably. The lake in most places is very deep, and marl is only obvious as a discontinuous fringe, 100-200 feet broad, around the shores. In many places these fringe areas and isolated marl patches are steep-sided and of high-purity. They have taken the form of shoals and bars as a result of wave and current action, and the marl is denser and purer because of the accompanying sorting action. Elsewhere the marl is less dense, and a higher content of organic impurities renders it dark-coloured.

Shells are present in minor amount in the marl; both gastropods and pelecypods are represented, and Chara stems are abundant. Organic material is practically absent except at the base of the marl section. Bedrock throughout the region is the Silurian Amabel Dolomite.

Bells Lake marl is of fairly good quality. A 17-foot section averaged 88.0 percent $CaCO_3$, 3.6 percent $MgCO_3$, 0.14 percent Fe_2O_3, and 0.83 percent insoluble. The dry powder is buff to buff-grey in colour with a moderately low brightness. Oil absorption is high. Natural particle size is 89 percent finer than 325 mesh; 68 percent finer than 10 micron. The crude marl averages 61.4 percent moisture; 640 pounds of dry marl are available in one cubic yard of the crude.

A section sampled on a marl bar at the narrows, located practically on the township boundary, is described in Section 11. Detailed analytical results for samples M27 and M28 are given in the Appendix.

Section 11 | Bells Lake

Depth below water (feet)	Description	Sample No.
0 - 3	Water.	
3 - 5	Marl: Cream-grey; very soft.	
5 - 19	Marl: Cream-grey; uniform; moderately dense; minor shell content; organic material scarce.	M27
19 - 22	Marl: Pale brown; dense; rare shells; moderate amount of finely-divided organic material.	M28
22 +	Clay: Grey; silty.	

(28) Tobermory Lake, Glenelg Township

Tobermory Lake is centred in lot 11, concession IE, Glenelg township, Grey county. It lies a few hundred yards east of highway No. 6, 6 miles north of Durham. Access to the lake is only available by the private cottage road of Mr. Harry Kress of Durham.

Tobermory Lake was controlled by the National Portland Cement Company of Durham as an alternate source of marl to their Wilder Lake reserves. However, Tobermory Lake does not appear to have ever been worked for marl.

The lake occupies an area of 50 acres. It is very deep except near shore. Mr. Kress says it is 30 feet deep in places. Two spring-fed creeks enter the lake on the north side, and an outlet drains to the Rocky Saugeen River.

Gastropod shells are especially common, and pelecypods and Chara debris are present. The content of fibrous organic material is moderately high. Amabel Dolomite of Silurian age is the bedrock throughout the area.

The marl of Tobermory Lake is of rather poor quality. An 18-foot section analysed 76.5 percent $CaCO_3$, 2.7 percent $MgCO_3$, 0.29 percent Fe_2O_3, and 2.44 percent insoluble. The content of organic carbon is large. Colour of the dry powder is dark

buff; the brightness value is low. Oil absorption is high. The crude marl averages 75.7 percent moisture; one cubic yard of crude contains 410 pounds of dry marl.

A section sampled in shallow water on the east side of the small island in the west-central portion of the lake is described in Section 12. Complete analytical results for sample M21 are given in the Appendix.

Section 12 | Tobermory Lake

Depth below water (feet)	Description		Sample No.
0 - 2	Water.		
2 - 20	Marl:	Medium grey-brown; upper part very soft; shells common; moderate amount of fibrous organic material.	M21
20 +	Clay:	Grey; stoneless.	

(29) Townsend Lake, Glenelg Township

Townsend Lake is located in lots 5 and 6, concessions XII and XIII, Glenelg township, Grey county. It lies in farmland 9 miles due north of Durham and 4 miles east of highway No. 6. The road between concessions XII and XIII follows the shore around the west side of the lake.

Townsend Lake, and the marsh area adjoining on the east side, occupies an area of 150 acres. The lake is spring-fed and uniformly shallow. Silurian Amabel Dolomite is the bedrock in the area.

Small white gastropod and pelecypod shells are present and fibrous organic material occurs in moderate amount. Rare grittiness in the marl is due to scattered grains of sand.

Townsend Lake marl is of poor quality. A 20-foot section averaged 59.5 percent $CaCO_3$, 4.2 percent $MgCO_3$, 0.33 percent Fe_2O_3, and 3.54 percent insoluble. Organic carbon must represent a considerable portion of the crude marl. The

dry powder is dark grey with a very low brightness. Oil absorption is moderately low. The crude marl is very fluid, containing 89.6 percent moisture. Only 180 pounds of dry marl could be recovered from one cubic yard of the crude.

The deposit was tested off the marsh area on the east side. The section is described in Section 13. Complete analytical results for sample M20 are given in the Appendix.

Section 13 | Townsend Lake

Depth below water (feet)	Description	Sample No.
0 - 2	Water.	
2 - 22	Marl: Grey-brown; very soft; 1/8-inch white gastropod shells common; moderately high organic content.	M20
22 - 27	Gyttja: Black; rubbery; uniform; shells and roots scarce.	
27 +	Sand: Grey; medium-grained; marly.	

(30) Williams Lake, Holland Township

Williams Lake occupies parts of lots 13-18, concessions I-II West, Holland township, Grey county. It lies on the west side of highway No. 10, 2 miles northwest of Holland Centre.

Marl was dredged from Williams Lake almost continuously during the years 1902-1913, and used for cement in a plant at Owen Sound 13 miles by rail to the north. Started as The Georgian Bay Portland Cement Company Limited, the plant was later operated under the name Imperial Cement Company. The operation is described by C. De Kalb (1900, p.108-109) and P. Gillespie (1905, p.144-146).

Williams Lake occupies an area of 140 acres, and low ground south of the lake may increase the total area underlain by marl by a further 100 acres. Patches of scrub poplar and cedar are scattered over the low marshy ground. The lakeshore

is quite sandy in places, and cottages are numerous.

The old workings are concentrated along the south and west sides of the lake. Workings on the south shore appear to have involved little more than stripping of black topsoil, exposing an orange marly sand and fine gravel. Bedrock is dolomite of the Guelph-Amabel Formations.

Williams Lake marl is very sandy and hence of poor quality. A 7½-foot sample taken in low ground south of the lake analysed 63.1 percent $CaCO_3$, 10.7 percent $MgCO_3$, 0.69 percent Fe_2O_3, and 28.76 percent insoluble. The dry powder is pale grey with a low brightness. Oil absorption is low. Natural particle size is 70 percent finer than 325 mesh, 43 percent finer than 10 micron. The crude marl contains 43.0 percent water; 935 pounds of dry marl are available in one cubic yard of the crude.

The marl was sampled near the concession road in low ground south of the lake. The section is given in Section 14, and complete analytical results for sample M71 are given in the Appendix.

Section 14 | Williams Lake

Depth below surface (feet)	Description	Sample No.
0 - ½	Black peaty loam.	
½ - 8	Marl: Cream-grey changing with depth to green-grey and olive brown; dense; gritty; rare shells and roots.	M71
8 - 11	Clay: Soft; limy; stoneless.	
11 +	Bedrock?	

(31) Bass Lake, Keppel Township

Bass Lake is a long narrow lake occupying part of lots 26-29, concession XVII-XIX, Keppel township, Grey county. It lies 7 miles east of Wiarton and is accessible at its southwest end. Here the lake is deep with high limestone shores. The lake bed is obviously marly.

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 4 - Williams Lake, Holland Tp., Grey Co.
The source of marl for the Imperial Cement Co.'s plant at Owen Sound, 1900-1913.

(32) Charles Lake, Keppel Township

Charles Lake occupies parts of lots 23-25, concessions XXIII and XXIV, Keppel township, Grey county. It lies 6 miles east of Wiarton, and is accessible by secondary roads along its north and east shores. Charles Lake is controlled by the Sauble Valley Authority, and a public park at the north end provides access to the lake.

Charles Lake occupies an area of 140 acres. The shores are low and stony, and tall cane reeds are common around the shallow fringe. Marl may also be found in a small (45 acres) lake one mile to the north, in lot 23, concessions XXV and XXVI. Dolomite of the Guelph-Amabel Formation is the bedrock.

A single species of gastropod is especially common in the marl. Silt and organic matter are also common.

Charles Lake marl is of poor quality. A 6-foot section analysed 64.6 percent $CaCO_3$, 3.5 percent $MgCO_3$, 1.03 percent Fe_2O_3, and 12.64 percent insoluble. The dry powder is grey with a very low brightness. Oil absorption is high. The crude marl is 75.2 percent water; 420 pounds of dry marl are available in one cubic yard of the crude.

A section sampled 100 feet offshore in the southwest part of the lake is described in Section 15. Complete analytical results for sample M47 are given in the Appendix.

Section 15	Charles Lake	
Depth below water (feet)	Description	Sample No.
0 - 2½	Water.	
2½ - 5	Marl: Very soft.	
5 - 11	Marl: Pale grey to brown; soft; silty; shells common; finely-divided organic matter common.	M47
11 - 14	Gyttja: Dark brown.	
14 +	Clay: Grey; silty.	

(33) Francis Lake, Keppel Township

Francis Lake occupies parts of lots 20-23, concession XIV, and lots 22 and 23, concession XV, in Keppel township, Grey county. It is located about midway between Wiarton and Owen Sound, and is accessible by secondary road at its south end.

Francis Lake is 200 acres in area. It has low stony shores, suggesting the dolomite bedrock is near-surface. Cottages are scattered along the south and east shores.

Shells are rather abundant in the marl. Three species of gastropod are especially common, but pelecypods and Chara debris are also present. Organic matter is scarce.

Francis Lake marl is of fair quality. An 11-foot section averaged 83.2 percent $CaCO_3$, 3.6 percent $MgCO_3$, 0.20 percent Fe_2O_3, and 1.82 percent insoluble. The dry powder is pale grey with a moderately low brightness. Oil absorption is relatively high. Particle size is 70 percent finer than 325 mesh, 45 percent finer than 10 micron. The crude marl is 68.0 percent moisture; 535 pounds of dry marlare contained in one cubic yard of the crude.

A section measured in the east-central part of the lake is given in Section 16. Complete analytical results for sample M46 are given in the Appendix.

Section 16 | Francis Lake

Depth below water (feet)	Description		Sample No.
0 - 5	Water.		
5 - 7	Marl:	Very soft.	
7 - 18	Marl:	Pale olive-grey; uniform; soft; shells common; organic matter scarce.	M46
18 +	Clay:	Grey; silty; stoneless.	

(34) Hepworth Lake, Keppel Township

Hepworth Lake, known also as Mountain Lake, is a large shallow lake, the main part of which occupies lots 14-20, concession XVIII, Keppel township, Grey county. It lies 5 miles southeast of Wiarton, and 12 miles northwest of Owen Sound. Secondary roads closely approach the lake both on its north and south sides, but access to the water's edge is restricted to private farm lanes.

The main west portion of Hepworth Lake occupies an area of 500 acres. The shoreline is low and stony, and the lake shallow and reedy. Amabel Dolomite is the bedrock.

Both gastropod and pelecypod shells are common in the marl, and Chara debris is present in moderate amount. Organic matter is not abundant.

Hepworth Lake marl is of fair quality. A 7-foot section analysed 80.5 percent $CaCO_3$, 3.4 percent $MgCO_3$, 0.36 percent Fe_2O_3, and 3.30 percent insoluble. The dry powder is grey with a low brightness. Oil absorption is high. Natural particle size is 77 percent finer than 325 mesh, 50 percent finer than 10 micron. The crude marl is 69.1 percent water; 515 pounds of dry marl can be extracted from one cubic yard of the crude.

A section measured near the centre of the large western bay is given in Section 17. Complete analytical results for sample M43 are given in the Appendix.

Section 17 | Hepworth Lake

Depth below water (feet)	Description	Sample No.
0 - 1½	Water.	
1½ - 4	Marl: Very soft.	
4 - 11	Marl: Buff-grey; soft; shells common; organic matter scarce.	M43
11 +	Silt: Medium grey; clayey.	

(35) McNab Lake, Keppel Township

McNab Lake occupies parts of lots 22-24 in the second concession north of Oliphant Road, and lots 13 and 14 in concession XII, Keppel township, Grey county. It lies 2 miles north of Shallow Lake, and 8 miles northwest of Owen Sound. A spur line formerly connected McNab Lake to the Shallow Lake-Owen Sound branch of the CNR.

Marl was dredged from McNab Lake from 1902 to 1911 by the Sun Portland Cement Company. It was conveyed 12 miles by rail to the company's plant at Owen Sound. The operation is described by Gibson (1903, p.31-32) and Gillespie (1905, p.159-160).

McNab Lake occupies an area of 450 acres. Dredging operations were confined to the south end and much of the marl remains untouched. The lake was drained at the time of the dredging, but the Sauble Valley Conservation Authority raised the water 3 feet in 1960. Much of the lake is covered by tall cane reeds.

Shells are common in the marl. Gastropods predominate, but pelecypods and Chara debris are also present. Fibrous organic matter is abundant in the upper few feet due to the prolific marsh growth that preceded the raising of the water level in 1960. The bedrock is Amabel Dolomite.

McNab Lake marl is of rather poor quality. A 10-foot section analysed 82.0 percent $CaCO_3$, 2.7 percent $MgCO_3$, 0.34 percent Fe_2O_3, and 2.96 percent insoluble. The dry powder is grey in colour with a low brightness. Oil absorption is moderate. Natural particle size is 49 percent finer than 325 mesh, 25 percent finer than 10 micron. The crude marl is 76.5 percent water; 400 pounds of dry marl are contained in one cubic yard of the crude.

A section was measured near the centre of the lake (Section 18). Complete analytical results for sample M42 are given in the Appendix.

Section 18	McNab Lake	
Depth below water (feet)	Description	Sample No.
0 - 4	Water.	
4 - 5	Peat: Fibrous.	
5 - 15	Marl: Olive-grey; soft; uniform; shells common; fibrous organic matter abundant at top.	M42
15 +	Bedrock: Coarse dolomite detritus on bedrock.	

(36) Shallow Lake, Keppel Township

Shallow Lake occupies parts of lots 5-9, concession VI, and lots 6-10, concession VII, Keppel township, Grey county. It lies on the southwest side of the village of Shallow Lake, 8 miles northwest of Owen Sound. The lake is accessible by road at its northeast and southwest ends, and a branch of the CNR lies along the west and north shores.

Shallow Lake was dredged for marl by The North American Chemical, Mining, and Manufacturing Company from 1889, and from sometime prior to 1900 until 1909 by the Owen Sound Portland Cement Company. From 1909 to 1914 it was worked by Canada Cement Company Limited, the Shallow Lake plant being known as plant No. 9 in the Canada Cement Company group. These operations are described by DeKalb (1900, p.108), Gibson (1902, p.32), and Gillespie (1905, p.154-157).

Shallow Lake occupies an area of 365 acres, much of which has been dredged for marl. Further reserves may be found in a low wooded area southeast of the lake. The remains of the cement plant are at the north end of the lake on the outskirts of the town; the foundations have been incorporated into a fur farm and a tile yard. Shallow Lake was drained during the dredging operations. Open water marks the dredged areas, but elsewhere the drained lands are open grassy marshes with patches of scrub willow and alder.

Both gastropod and pelecypod shells are present in the marl in moderate numbers, and Chara debris is common. Organic matter is also present in moderate amount. Amabel Dolomite of

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 5 - Shallow Lake, Keppel Tp., Grey Co.
The deposit was continuously dredged, 1889-1914.
Foundations of the old cement plant can be seen at the top, right of centre.

Silurian age is the bedrock.

Shallow Lake marl is of fair quality. A 5-foot section averaged 87.0 percent $CaCO_3$, 2.9 percent $MgCO_3$, 0.34 percent Fe_2O_3, and 1.96 percent insoluble. The dry powder is pale grey with a moderate brightness. Oil absorption is moderate. Natural particle size is 87 percent finer than 325 mesh, 63 percent finer than 10 micron. The crude marl is 47.3 percent water; 870 pounds of dry marl are contained in one cubic yard of the crude. Chemical analyses for Shallow Lake marl are also given by Miller (1904, p.51) and Gillespie (1905, p.183).

A section measured near the centre of an open grass meadow at the south end of the drained-lake area is given in Section 19. Early reports (Gillespie 1905, p.156; Miller 1904, p.51) confirm the shallow depth of the marl deposit. Complete analytical results for sample M41 are given in the Appendix.

Section 19 | Shallow Lake

Depth below surface (feet)	Description	Sample No.
0 - 1	Topsoil: Grey-black; marly.	
1 - 6	Marl: Pale grey, grading downwards to medium grey and pale pink-brown; dense; moderate content of shells and fibrous organic matter.	M41
6 +	Clay: Medium grey; smooth; stoneless.	

(37) Shallow Lake Marsh, Keppel Township

Marl underlies low ground ½ mile northeast of Shallow Lake along the road to McNab Lake. The Grey and Bruce Portland Cement Company commenced operations in 1902, dredging marl from lot 20, concession II South, Keppel township, Grey county. The marl was hauled by rail 9 miles to the plant at Owen Sound (Gillespie 1905, p.141-142). Use of marl from this location was apparently short-lived as the workings are shallow and not extensive.

Testing of the section at the northeast end of the dredged area revealed only 2 feet of dense pink-grey marl beneath 1 foot of peaty topsoil. Grey stoneless clay underlies the thin marl bed. An analysis of the marl is reported by Gillespie (1905, p.183) as follows:

	Percent
$CaCO_3$	84.91
$MgCO_3$	2.89
SiO_2	2.00
Al_2O_3	0.84
Fe_2O_3	0.50
SO_3	1.21
Ignition loss	6.60

(38) Wiarton Marsh, Keppel Township

A wooded marsh area adjoining Gleason Brook on the east side of Wiarton airport is largely contained by lots 10 and 11, concession XXII, Keppel township, Grey county. The area lies off the east end of the airport runways, 2½ miles east of Wiarton. It is accessible by secondary road along the line between lots 10 and 11.

Marl was dredged from the area in 1907 and 1908 during the short productive life of the Colonial Portland Cement Company. The name was changed to Crown Portland Cement Company in 1909 but no further production is recorded. A description of the plant and marl deposit during the development period is given by Gillespie (1905, p.139-141).

A thin marl bed may underlie 150 acres of wooded swampland along Gleason Brook. The area is densely overgrown with willow and alder scrub and a moderate growth of hardwood. A single dredged channel 1,500 feet long is located in lot 10, parallel to and 700 feet west of the road. The area lies close to the bedrock contact between dolomite of the Amabel Formation and sandstone, shale, and dolomite of the Clinton and Cataract Groups.

Shells are present in minor amount in the marl; pelecypods predominate. Organic matter is scarce.

The marl is of fair quality. A 3-foot sample gave on

analysis: 84.1 percent $CaCO_3$, 3.5 percent $MgCO_3$, 0.46 percent Fe_2O_3, and 2.98 percent insoluble. The dry powder is pale grey with a moderate brightness. Oil absorption is high. Natural particle size is 87 percent finer than 325 mesh, 65 percent finer than 10 micron. The crude marl is 53.6 percent water; 770 pounds of dry marl are contained in one cubic yard of the crude.

A section sampled midway along, and 100 feet east of, the dredged channel is given in Section 20. Complete analytical results for sample M45 are given in the Appendix.

Section 20 | Wiarton Marsh

Depth below surface (feet)	Description	Sample No.
0 - 1	Topsoil: Black; loamy.	
1 - 4	Marl: Pale grey; dense; minor content of shells; organic matter scarce.	M45
4 +	Bedrock: Fine grey sand on bedrock.	

(39) Wolseley Lake, Keppel Township

Wolseley Lake, or Lake Scale as it is known locally, is largely contained by lots 22 and 23, concession XX, Keppel township, Grey county. It lies 6 miles east of Wiarton, and is accessible by a secondary road that bends around the wooded shore at its south end.

The marl of Wolseley Lake was held in reserve by the Colonial Portland Cement Company. The company made cement in their Wiarton plant during 1907 and 1908, using marl from a marsh area east of Wiarton. The plant was closed after this short productive life, and the Wolseley Lake marl was never used. A description of the plant and marl deposits during the development period is given by Gillespie (1905, p.139-141).

Wolseley Lake occupies an area of 180 acres, 65 acres of which is open water; the rest is a broad fringe of reeds and grass sufficiently firm to support a man. The wooded shores

are gently sloping. Bedrock in the area is predominantly Silurian dolomite.

Both gastropod and pelecypod shells are common and largely represented by a single species of each. Organic matter is not abundant.

Wolseley Lake marl is of fair quality. A 10-foot section averaged 80.9 percent $CaCO_3$, 3.4 percent $MgCO_3$, 0.30 percent Fe_2O_3, and 3.06 percent insoluble. The dry powder is grey with a low brightness, and the oil absorption is high. Natural particle size is 57 percent finer than 325 mesh, 31 percent finer than 10 micron. The crude marl is 70.0 percent water; 500 pounds of dry marl are contained in one cubic yard of the crude.

A section sampled well out on the marsh fringe, at the southern edge of the open water, is described in Section 21. Complete analytical results for sample M44 are given in the Appendix.

Section 21	Wolseley Lake	
Depth below surface (feet)	Description	Sample No.
0 - 1	Peat: Fibrous.	
1 - 3	Marl: Very soft.	
3 - 13	Marl: Olive-grey; soft, becoming denser at depth; shells common; fibrous organic matter scarce.	M44
13 +	Bedrock: Grey silty detritus on bedrock.	

HALTON COUNTY

(40) Lake Medad, Nelson Township

Marl underlies Lake Medad in lot 24, concession II N.D.S., Nelson township, Halton county. The lake is 2½ miles north of Waterdown. Marl may also underlie the long narrow marsh

that extends for several miles north from the lake.

The deposit occurs in a narrow erosion basin along the west side of a low scarp of Guelph-Amabel Dolomite. According to A.R. Crozier (unpublished report, 1938) the marl varies to more than 10 feet in thickness and underlies 1-2½ feet of peat. The marl is grey-white in colour and has a low content of organic impurities. A grab sample analysed by W.F. Green (Provincial Assayer, 1938) gave the following composition:

	Percent	
CaO	52.20	equivalent to 93.18% $CaCO_3$
MgO	1.52	equivalent to 3.18% $MgCO_3$
SiO_2	1.07	
$Fe_2O_3 + Al_2O_3$	0.16	
Ignition loss	45.83	includes Moisture = 1.94 CO_2 = 43.00
	99.89	

(41) Kilbride, Nelson Township

A deposit of marl occurs in low ground on a tributary of Bronte Creek, on lot 13, concession II, Nelson township, Halton county. The deposit is 2 miles northwest of Kilbride, 3 miles southeast of Campbellville.

The marl was being used in the manufacture of concrete sewer pipe and culvert tile by W.O. Morse in 1921. This company was succeeded by General Calcium Corporation Limited in 1928.

HASTINGS COUNTY

(42) Cashel Lake, Cashel Township

According to S.B. Lumbers (1968, p.47) marl occurs in Cashel Lake, particularly the southwest and east central parts, lots 24-25, concession V-VI, Cashel township, Hastings county.

(43) Gunter Lake, Cashel Township

Marl is particularly common in a shallow bay in the southwest part of Gunter Lake, lot 24, concession IV, Cashel township, Hastings county (S.B. Lumbers, 1968, p.47).

(44) Mephisto Lake, Cashel Township

Marl is found in a few shallow bays of Mephisto Lake, lots 25-30, concession VIII-IX, Cashel township, Hastings county (S.B. Lumbers, 1968, p.47).

(45) Dry Lake, Hungerford Township

Dry Lake is located in lots 32 and 33, concession II, Hungerford township, Hastings county. It lies less than one mile southwest of Marlbank, and 15 miles north of Napanee. It is readily accessible by road.

Marl was dredged from Dry Lake by The English Portland Cement Company (1891-1898), The Beaver Cement Company (1898-1900), The Canadian Portland Cement Company (1900-1909), and the Canada Cement Company Limited (1909-1914). The marl was used in cement plants at Strathcona (1891-1903) and Marlbank (1891-1914). The Strathcona plant had been a producer of "natural" cement using Trenton Limestone; the plant had been established in 1880 by The Rathbun Company. Reports on these operations are given by DeKalb (1900, p.109) and Gillespie (1905, p.136-139). During World War II The Ontario Paper Company took marl from an area south of the road at the south end of Dry Lake as a substitute paper filler for English chalk. The company also removed a small amount of marl from a marsh area ½-mile north of Marlbank.

Dry Lake occupies an area of 225 acres. Dredged areas total 105 acres, so that 120 acres of marl remain. Most of the remaining marl underlies the marl flats along the west side of the lake. The marl here is more densely packed, as a result of draining the lake at the time of the early dredging operations, and the dry surface will support a man. Open water marks the areas of former dredging activity, but scattered

ridges and irregular marl remnants are present. The foundations of the Marlbank cement plant are located on the south side of the Tweed road at the northwest corner of the lake.

Dry Lake marl contains a very high proportion of the minute remains of the alga Chara. Shells are represented in minor amount by two species of gastropod. Organic material is scarce. The bedrock is Ordovician limestone of the Black River Formation.

Dry Lake marl is of excellent quality. A 10½-foot section averaged 92.5 percent $CaCO_3$, 2.1 percent $MgCO_3$, 0.07 percent Fe_2O_3, and 0.39 percent insoluble. The dry powder from the top 3 feet is cream-white with a brightness value of 73.0, and a low oil absorption. The lower two-thirds of the section is slightly less pure, and has a lower brightness and higher oil absorption. The natural particle size is 92 percent finer than 325 mesh, 67 percent finer than 10 micron. Moisture constitutes 60.0 percent of the complete section; 665 pounds of dry marl can be obtained from one cubic yard of the crude.

A section sampled in the south-central part of the marl flats along the west side of the lake is described in Section 22. Detailed analytical results for samples M30 and M31 are given in the Appendix.

Section 22 | Dry Lake

Depth below surface (feet)		Description	Sample No.
0 - ½	Marl:	Grey; dense; hard-packed.	
½ - 3½	Marl:	Cream-white; moderately soft; shells and organic material scarce.	M30
3½ - 11	Marl:	Pale buff; moderately dense; shells and organic material scarce.	M31
11 +	Clay:	Medium grey; silty; stoneless.	

In 1965 W.H. Richards of Toronto drilled thirty auger holes, about 6 inches in diameter, spaced at 100-foot centres on a square grid along the west shore. Five samples of about 50 pounds each were evaluated by the Laboratory Branch, Ontario Department of Mines, with the results shown in Table 6.

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 6 - Dry and Lime Lakes, Hungerford Tp., Hastings Co. Dry Lake was dredged by a succession of cement companies, 1891-1914. It was also taken from a small area at the south end, between the roads, as a substitute paper filler in the 1940's.

Average moisture content of the samples was 44.8 percent; 900 pounds of dry marl are contained in one cubic yard of the crude.

Table 6 | Dry Lake Marl - W.H. Richards samples

	AB-1 percent	AW-1 percent	AW-2 percent	AW-3 percent	AW-4 percent
CaO	54.1	54.0	53.6	53.7	53.4
MgO	0.28	0.15	0.38	0.12	0.14
Fe_2O_3	0.03	0.02	0.02	0.02	0.05
Loss on ignition	44.8	45.1	44.9	44.9	44.9
Insoluble	0.04	0.05	0.00	0.05	0.00
Total	99.3	99.3	98.9	98.8	98.5
Calculated $CaCO_3$	96.6	96.4	95.7	95.9	95.3
Calculated $MgCO_3$	0.9	0.5	1.2	0.4	0.4
Total carbonate	97.5	96.9	96.9	96.3	95.7
Brightness	77.5	78.0	78.1	78.4	80.0
Oil absorption	46.6	45.8	45.6	45.9	43.0

Average particle size of the five samples was 89 percent finer than 100 mesh, 86 percent finer than 325 mesh, and 63 percent finer than 10 micron.

The uniformity and high-quality of this deposit is indicated by these samples.

(46) Lime Lake, Hungerford Township

Lime Lake straddles the county boundary. The east half of the lake is in lots 31-35, concession I, Hungerford township, Hastings county. The west end extends onto lots 1-8, concession XI, Richmond township, county of Lennox and Addington. Lime Lake lies several miles southwest of Marlbank, about 15 miles north of Napanee. A secondary road parallels the lake at a distance of ¼-mile along the north side, but there appears to be no public access.

The marl in Lime Lake and nearby Inglesby (White) Lake was held in reserve by The Canadian Portland Cement Company for the Marlbank cement plant (Gillespie, 1905, p.137), but there was no production.

Lime Lake is a long narrow lake separated from Dry Lake by the Marlbank esker. The lake occupies an area of 285 acres, but low wooded ground between the northeast end of the lake and the esker may increase the area underlain by marl by more than 300 acres. The lake is moderately deep, but a broad irregular fringe of marl is conspicuous on aerial photographs. Cottages are common along the southwest shore, but the main marl area at the northeast end is undeveloped.

Lime Lake marl contains a high proportion of Chara debris. Shells are rather scarce and virtually restricted to one species of gastropod. Fibrous organic material is scarce, but finely-divided organic matter is noticeable near the base. Bedrock is Ordovician limestone.

Lime Lake marl is of uniformly high-quality. A 21-foot section averaged 91.3 percent $CaCO_3$, 2.2 percent $MgCO_3$, 0.06 percent Fe_2O_3, and 0.36 percent insoluble. The dry powder is cream-grey, with moderately high values for brightness and oil absorption. Natural particle size is 84 percent finer than 325 mesh, 60 percent finer than 10 micron. The crude marl averages 53.4 percent moisture; 775 pounds of dry marl are present in one cubic yard of the crude.

A section sampled at the water's edge in an open grass meadow midway along the north shore is given in Section 23, Detailed analytical results for samples M32, M33, and M34, are given in the Appendix.

Section 23	Lime Lake	
Depth below surface (feet)	Description	Sample No.
0 - 3	Peat: Fibrous to slightly humified.	
3 - 10	Marl: Cream-grey; soft; shells and organic matter scarce.	M32
10 - 19	Marl: Buff-cream; moderately soft; occasional shells organic matter scarce.	M33
19 - 24	Marl: Buff-grey; moderately soft; rare shells; minor greenish organic matter.	M34
24 +	Clay: Dark grey; silty; stoneless.	

(47) Marlbank Marsh, Hungerford Township

A marshy area northeast of Dry Lake occupies parts of lots 34-35, concession III, Hungerford township, Hastings county. It lies ½ mile north of Marlbank, and extends on both sides of the gravel road that runs north from the town.

During World War II a small amount of marl was taken by The Ontario Paper Company from an area just west of the road. The excavation is about 200 feet square and 6 feet deep. In 1966 a sampling program and market survey was carried out by Barringer Research Limited for Paul E. Bourdon of Montreal. Test holes were made with a peat sampler along an east-west line extending from the western edge of the property, 1,000 feet west of the road, to a point 600 feet east of the road where the ground became too wet to proceed further. Marl was encountered in all holes to a depth of about 15 feet.

It is likely that marl underlies at least 60 acres of low ground in this area. Much of the area is dry, sparsely-wooded, and firm.

As with the Dry Lake marl a high proportion of the alga Chara is represented in the shell fragments. Shells of two species of gastropod are also present. Organic material is scarce. The bedrock is Ordovician limestone of the Black

River Group.

Quality of the marl is excellent, probably comparable in every way to that of nearby Dry Lake. A 15½-foot section averaged 93.0 percent $CaCO_3$, 1.2 percent $MgCO_3$, 0.09 percent Fe_2O_3, and 1.37 percent insoluble. The upper 5½ feet is cream-white with a brightness value of 72.2. Oil absorption is low to moderate. Natural particle size is 82 percent finer than 325 mesh, and 50 percent finer than 10 micron. Average moisture content is 52.7 percent; 780 pounds of dry marl are available in one cubic yard of the crude.

A section sampled on the north edge of the excavated area, at a point 300 feet west of the road, is described in Section 24. Complete analytical results for samples M57 and M58 are given in the Appendix.

Section 24	Marlbank Marsh		
Depth below surface (feet)		Description	Sample No.
0 - ½	Topsoil.		
½ - 6	Marl:	White; dense; shells and organic material scarce.	M57
6 - 16	Marl:	Pale brown grading downwards through pink-brown to olive-green; dense; shells and organic material scarce.	M58
16 +	Clay:	Grey; stoneless.	

(48) Marland Lake, Hungerford Township

The soil survey map (J.E. Gillespie et al., 1962) of Hastings county indicates an area of several hundred acres underlain by marl east of Marland lake, on or about lot 26, concession III, Hungerford township, Hastings county. Marland Lake and the adjoining marsh may also be underlain by marl. The area lies 4-5 miles west of Marlbank.

(49) Drag Lake, Huntingdon Township

Drag Lake occupies the southern parts of lots 18 and 19, concession IX, Huntingdon township, Hastings county. It lies 6 miles southeast of Madoc and 5 miles west of Tweed. A C.P.R. branch line follows its southeast shore. Drag Lake is only accessible by a farm lane on the south side.

The lake occupies an area of about 100 acres. Broad marl shoals are obvious in the eastern arm of the lake, around the island in the central part, and fringing low ground towards the west. Elsewhere the water is deep. Ordovician limestone of the Black River-Trenton Group is the bedrock in the area.

A variety of gastropod shells are present, and Chara fragments are common. The marl is brown and peaty at the base.

Drag Lake marl is of good quality. An 18-foot section averaged 91.5 percent $CaCO_3$, 1.1 percent $MgCO_3$, 0.11 percent Fe_2O_3, and 0.67 percent insoluble. The dry powder is cream-coloured with a moderate brightness. Oil absorption is rather high. Natural grain size is 65 percent finer than 325 mesh, 45 percent finer than 10 micron. The crude marl contains 51.5 percent water; 800 pounds of dry marl can be obtained from one cubic yard of the crude.

The marl was sampled at the edge of a cane marsh on the south side of the island in the central part of the lake. The section is described in Section 25. Detailed results of testwork on samples M59 and M60 are given in the Appendix. A description of the marl is also given by G.C. Hoffmann (1894, p.27).

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 7 - Drag Lake, Huntingdon Tp., Hastings Co. Note the narrow marl fringe.

Section 25 | Drag Lake

Depth below water (feet)	Description	Sample No.
0 - 1½	Water.	
1½ - 2	Marl: Grey; gritty.	
2 - 15	Marl: Cream-grey; soft; gritty; occasional shells and roots.	M59
15 - 20	Marl: Pale brown becoming darker with depth; dense; occasional shells.	M60
20 - 21	Gyttja: Dark brown; rubbery.	
21 +	Clay: Medium grey; stoneless.	

(50) White Lake, Huntingdon Township

White Lake is located in lots 10 and 11, concession X, Huntingdon township, Hastings county. It lies in a depression on the east side of highway No. 62 and the Madoc-Belleville branch of the C.N.R., 5 miles south of Madoc. It is inaccessible except on foot from the highway or railway right-of-ways.

White Lake occupies an area of 90 acres. The shores are low and wooded except at the south end where cleared pastureland meets the shore at several points. The lake is deep except for a narrow, shallow-water, marl fringe along the east and north shores. A small lake, 25 acres in area and ¾-mile north of White Lake, also appears to contain marl. The low wooded ground between the two lakes may also be underlain by marl.

Shells are rather common in White Lake marl; gastropods predominate. Chara debris is abundant, and organic matter is present in moderate amount. Ordovician limestone is the bedrock in the area.

White Lake marl is of good quality. A 22½-foot section averaged 91.4 percent $CaCO_3$, 1.4 percent $MgCO_3$, 0.07 percent Fe_2O_3, and 0.44 percent insoluble. The dry powder is pale grey with a moderately low brightness. Oil absorption is high. Natural particle size is 79 percent finer than 325 mesh, 60 percent finer than 10 micron. The crude marl averages 62.2

percent water; 630 pounds of dry marl can be extracted from one cubic yard of crude. Miller (1904, p.66) also gives a chemical analysis for the White Lake marl.

A section sampled 25 feet offshore in shallow water at the southwest end of the lake is described in Section 26. Complete analytical results for samples M36 and M37 are given in the Appendix.

Section 26 | White Lake

Depth below water (feet)	Description	Sample No.
0 - 3	Water.	
3 - 6	Marl: Pale grey; very soft; fluid.	
6 - 24	Marl: Pale grey; soft; moderate content of shells; minor amount of fibrous organic matter.	M36
24 - 28½	Marl: Buff-grey; moderately dense; occasional shells; small amount of finely-divided organic matter.	M37
28½ +	Gyttja: Brown-black.	

(51) Blue Sea Lakes, Limerick Township

According to F.D. Adams and A.E. Barlow (1910, p.387-388) marl is abundant in the Blue Sea Lakes, lots 1-2, concession XIII, Limerick township, Hastings county.

(52) Egan Lake, Limerick Township

According to S.B. Lumbers (1968, personal communication) marl occurs in Egan Lake. Egan Lake is centred in lots 3-4, concession XVI, Limerick township, Hastings county.

(53) Queensborough, Madoc Township

A marl bed is indicated along the east side of a small pond centred on the boundary between lots 10 and 11, concession X, Madoc township, Hastings county (Miller and Knight, 1913, map No. 22C). The pond is 2 miles southwest of Queensborough.

(54) Snow Lake, Wollaston Township

Marl is found beneath the shallow waters of Snow Lake, lot 24, concession IX, Wollaston township, Hastings county. The marl is reported to be overlain by 4 inches of sand (F.D. Adams and A.E. Barlow 1910, p.387).

LANARK COUNTY

(55) Joe Lake, Lavant Township

A small marl deposit is mentioned (G.C. Hoffmann, 1894, p.24-25) in Joe Lake, lot 13, concession IV, Lavant township, Lanark county. It is said to cover an area of 6 acres and to be more than 7 feet deep. The cream-coloured marl contains few shells and root fibres, and analysed:

	Percent	
CaO	53.17	Calculated $CaCO_3$ = 94.95%
MgO	0.06	Calculated $MgCO_3$ = 0.13%
Fe_2O_3	0.08	
Insoluble	0.24	
Ignition loss	45.68	

The writer visited the location in 1965, but significant amounts of marl were not in evidence.

LEEDS COUNTY

(56) Bass Lake, South Elmsley Township

Marl ".... is found underlying portions of Bass Lake, of a thickness from three to four feet, but the exact extent of the deposit is not known." (P. Gillespie, 1905, p.121). The lake is 8 miles southwest of Smith's Falls. It is a large lake, occupying much of lots 23-28, concessions III-IV, South Elmsley township, Leeds county. The lake bottom did not appear to the writer to be obviously marly. Cottages are common along the east side.

(57) Otter Lake, South Elmsley Township

Otter Lake lies largely within the south corner of South Elmsley township in Leeds county. Highway No. 15 and the C.N.R. lie parallel along its east side, providing access from Smiths Falls 10 miles to the northeast.

Marl is most apparent at the south end of the lake where broad marl shoals follow the shoreline fairly continuously. These shoals total about 65 acres in area. Elsewhere the lake is deep and cottages are numerous. Bedrock is mostly white marble.

Several species of shells are present in small numbers. Fine roots are occasionally present. The marl bed does not make sharp contact with the underlying clay but grades into it through a range of several feet.

Otter Lake marl is of rather poor quality. An 8-foot section analysed 83.8 percent $CaCO_3$, 3.2 percent $MgCO_3$, 0.10 percent Fe_2O_3, and 1.36 percent insoluble. Colour of the dry powder is pale grey of fairly low brightness. Oil absorption is moderately high. Natural particle size is 82 percent finer than 325 mesh, 60 percent finer than 10 micron. Crude marl contains 66.3 percent moisture; 560 pounds of dry marl are available in one cubic yard of the crude.

The marl was sampled near the centre of a 15-acre bay on the east shore at the south end of the lake (Section 27). Analytical results for sample M69 are given in the Appendix.

Section 27 | Otter Lake

Depth below water (feet)	Description		Sample No.
0 - 3	Water.		
3 - 11	Marl:	Pale grey changing to pale brown at depth; soft to moderately dense; low content of shells and roots.	M69
11 - 13	Marl:	Grey; somewhat clayey.	
13 - 14	Clay:	Medium grey; marly; gritty.	

(58) Athens, Rear of Yonge and Escott Township

A deposit of marl 1 mile south of Athens is described by R.W. Ells (1902, p.64) as occurring ".... over an area of at least 25 acres, with an ascertained depth of seven to fifteen feet." The deposit underlies a marsh on lot 13, concession VIII, Rear of Yonge and Escott township, Leeds county.

(59) Mud Lake, Rear of Yonge and Escott Township

R.W. Ells (1902, p.64) refers to marl in the bottom of Mud Lake, lots 7-9, concession IX, Rear of Yonge and Escott township, Leeds county. Mud Lake lies 1½ miles north of Athens.

LENNOX AND ADDINGTON COUNTY

(60) Clareview, Sheffield Township

Marl underlies a low open marsh in lots 14 and 15, concession II, Sheffield township, Lennox and Addington county. The area is ½-mile south of the settlement of Clareview, 6 miles north of Marlbank. It is accessible on the east side by gravel road, a distance of just over a mile

from highway No. 41.

Clareview swamp is an open reed marsh, spotted with cedar and tamarack scrub and outlined by a dense cedar fringe. It occupies an area of about 60 acres.

A wide variety of shells are present but none are abundant. Fine dark brown roots are common. The deposit is close to the bedrock contact between Grenville granitic rocks and Paleozoic limestone of the Trenton - Black River Group.

Marl from the Clareview swamp is of only fair quality because of the darkening caused by organic matter. An 8½-foot section analysed 88.4 percent $CaCO_3$, 2.2 percent $MgCO_3$, 0.11 percent Fe_2O_3, and 0.84 percent insoluble. The dry powder is pale grey with a low brightness. Oil absorption is moderately high. Natural particle size is 70 percent finer than 325 mesh, 48 percent finer than 10 micron. The crude marl contains 65.8 percent moisture; 570 pounds of dry marl can be recovered from one cubic yard of the crude.

The swamp was sampled in the north-central part; the section is reproduced in Section 28. Detailed analytical data for sample M63 are given in the Appendix. G.C. Hoffmann (1894, p.25-26) also gives a chemical analysis.

Section 28 | Clareview swamp

Depth below surface (feet)	Description	Sample No.
0 - ½	Water, reeds, and grass.	
½ - 2½	Peat: Fresh, fibrous.	
2½ - 3½	Marl: Very soft; organic.	
3½ - 12	Marl: Pale mauve-brown; soft to moderately dense; fine dark brown roots and yellow-white shells becoming less common with depth.	M63
12 +	Clay: Medium grey; smooth, stoneless.	

(61) Erinsville, Sheffield Township

A deposit one mile north of Erinsville is described by

W.E. Logan (1863, p.764) as follows: ".... the marl, whose thickness has not been ascertained, extends over three or four hundred acres of marshy land, which is covered by about four feet of peat." The marsh is centred in lot 12, concession IV, Sheffield township, Lennox and Addington county.

(62) Inglesby (White) Lake, Sheffield Township

Inglesby Lake is located in lots 4 and 5, concession II, and lots 5 and 6, concession III, Sheffield township, Lennox and Addington county. It lies 2 miles east of Marlbank, and 18 miles north of Napanee. The northwest shore of the lake is accessible by paved road from Marlbank, or by highway No. 41 on the east.

The marl in Inglesby (White) Lake and nearby Lime Lake was held in reserve by The Canadian Portland Cement Company for the Marlbank cement plant (Gillespie, 1905, p.137), but it was never used.

Inglesby Lake occupies an area of 440 acres, of which 275 acres are contained in a broad, shallow-water, marl fringe. A few scattered cottages are present, but the shores are mostly open, or sparsely treed, farmland. The roadbed of an abandoned railway can be traced along the west shore.

The marl contains occasional shells of the gastropod family, and debris of the alga Chara is common. Fibrous organic material is present in moderate amount. Bedrock in the area is Black River Limestone.

Marl of Inglesby Lake is of fairly good quality. A 6-foot sample analysed 87.3 percent $CaCO_3$, 2.9 percent $MgCO_3$, 0.12 percent Fe_2O_3, and 1.20 percent insoluble. The dry powder is pale grey and has a moderate brightness. Oil absorption is high. Natural particle size is 85 percent finer than 325 mesh; 61 percent finer than 10 micron. The crude marl contains 57.2 percent moisture; 710 pounds of dry marl are contained in one cubic yard of the crude.

A section sampled in marshland at the water's edge at the southwest end of the lake is given in Section 29. The marl section is probably thicker elsewhere in the deposit. Complete analytical results for sample M35 are given in the Appendix.

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 8 - Inglesby (White) Lake, Sheffield Tp., Lennox and Addington Co. Note the broad marl fringe.

Section 29	Inglesby (White) Lake

Depth below surface (feet)	Description	Sample No.
0 - 3	Peat and soft marl.	
3 - 9	Marl: Buff-grey; moderately dense; occasional shells; moderate amount of fibrous organic matter.	M35
9 - 11	Gyttja: Brown; dense.	
11 - 12	Clay: Peaty.	
12 +	Clay: Medium grey; silty; stoneless.	

DISTRICT OF MANITOULIN

(63) Ice Lake, Allan Township

W.G. Miller (1904, p.80) mentions the incorporation of The Manitoulin Portland Cement Company, formed with the intention of erecting a cement plant near a source of water power and shale at Kagawong. It was proposed to obtain marl from Ice Lake, lots 20-27, concessions IV-IX, Allan township, district of Manitoulin. The scheme appears not to have been developed.

DISTRICT OF NIPISSING

Emerald Lake, McAuslan Township

The original description of Emerald Lake by A.E. Barlow (1897, p.155-157) favours that of nearby Troutbait Lake in Parkman township. The lake now designated as Emerald appears to have been mis-named. To the writer's knowledge marl is not present.

(64) Troutbait Lake, Parkman Township

Originally known as Emerald Lake, the name is believed to have been erroneously applied to a larger neighbouring

lake in McAuslan township. Troutbait Lake is located on the south boundary of Parkman township, a little more than 4 miles southwest of Opimika Narrows on Lake Timiskaming. Marl also occurs in two small lakes one mile northwest of Troutbait Lake.

A.E. Barlow (1897, p.155-157) describes the Troutbait Lake occurrence as follows:

"At the south-east corner is a very shallow bay, affording entrance to a stream which is fed by a number of large cold springs that rise at the base of an amphitheatre-like gully, at the base of steep banks composed mainly of sand and gravel. The water of the bay, although so shallow, is very cold even during the hottest days of summer, while the whole bottom is covered with a deposit of shell marl of unknown depth. That this depth is considerable there is no reason to doubt, as the soundings made with long poles failed to reach the bottom of the deposit. Besides this bay the whole lake contains marl deposited on the bottom, while the pebbles and boulders near the outlet show a considerable coating of this loosely coherent, earthy carbonate of lime."

A summary of the analysis he gives for the marl is as follows:

	Percent	
CaO	48.32	Calculated $CaCO_3$ = 86.28%
MgO	0.04	Calculated $MgCO_3$ = 0.08%
Fe_2O_3	0.08	
Insoluble	8.62	
Ignition loss	42.99	Includes CO_2 = 38.01
		Organic matter = 4.79
	100.05	

ONTARIO COUNTY

(65) Chalk Lake, Reach Township

Chalk Lake, occupies parts of lots 1 and 2, concession I, and lot 1, concession II, in Reach township, Ontario county. It lies 12 miles due north of Pickering, and is accessible by secondary road a distance of 6 miles north from highway No. 7. Chalk Lake is 2 miles north of Dagmar Station

on the C.P.R.

Chalk Lake occupies an area of 50 acres. The lake is deep and the shoreline high. Cottages are numerous along the steep north shore. Bedrock in the area consists of grey and black shales of the Ordovician Collingwood Formation, but the drift cover is heavy. The lake lies along the southern edge of the Oak Ridges moraine.

Shells are only occasionally present in the marl; gastropods and Chara debris were recognized. Fibrous organic material is not common, but finely-divided plant remains contribute a dark colour to the crude marl.

The marl of Chalk Lake is of only fair quality. A 17-foot section, omitting a 1½-foot peat layer near the base, analysed 87.0 percent $CaCO_3$, 1.6 percent $MgCO_3$, 0.14 percent Fe_2O_3, and 2.84 percent insoluble. The dry powder is buff coloured with a moderately low brightness, and the oil absorption is moderately high. Natural particle size is 70 percent finer than 325 mesh, 34 percent finer than 10 micron. The crude marl is 63.8 percent water; 605 pounds of dry marl are contained in one cubic yard of the crude.

The marl was tested 25 feet offshore about midway along the south shore of the lake, and the section is described in Section 30. A similar section was also recorded along the south shore near the west end of the lake. Complete analytical results for sample M29 are given in the Appendix. G.C. Hoffmann (1894, p.26) also gives an analysis for the marl.

Section 30 | Chalk Lake

Depth below water (feet)		Description	Sample No.
0 - 4	Water.		
4 - 9	Marl:	Buff-brown; very soft; occasional shells; some fibrous organic material.	M29
9 - 16½	Marl:	Buff to olive-grey; soft; shells scarce; fibrous organic material rare.	M29
16½- 18	Peat:	Medium brown; fibrous; marly.	
18 - 21	Marl:	Buff-grey; moderately dense.	M29
21 +	Clay:	Grey; soft; silty; limy.	

PEEL COUNTY

(66) Orangeville, Caledon Township

Marl underlies low ground west of Caledon Lake in part of lots 31, concessions IV and V, Caledon township, Peel county. The deposit extends also into lot 1, concession B, East Garafraxa township, Dufferin county. The marl beds are 3 miles southwest of Orangeville, and are accessible by the boundary road across the northwest corner of the township.

Marl was dredged by the Superior Portland Cement Company from 1907 to 1913. A railway, now abandoned, connected the plant at Orangeville with the marl workings. A description of the plant during its construction is given by Gillespie (1905, p.160-162).

The marl deposit is not extensive, and it may have been largely depleted during the years it was worked. The workings occupy an area of 35 acres and a summer cottage community has been developed on the dredged canals. Marl does not underlie "Second Lake" to the east, but the beach on the east shore of Caledon Lake is composed of impure shell marl. The marl area is rather heavily wooded.

A wide variety of shells characterize the Orangeville marl; species of gastropod, pelecypod, ostracod, and Chara debris occur in moderate amount. Fibrous organic matter is not abundant. Silurian dolomite of the Amabel Formation is the bedrock in the area.

Orangeville marl is of fair quality. A 2-foot section averaged 90.3 percent $CaCO_3$, 3.3 percent $MgCO_3$, 0.49 percent Fe_2O_3, and 0.82 percent insoluble. The dry powder is buff-cream in colour with a relatively good brightness. Oil absorption is moderate. Natural grain size averages 81 percent finer than 325 mesh, 33 percent finer than 10 micron. The crude marl is 53.6 percent water; 770 pounds of dry marl are contained in one cubic yard of the crude.

A section sampled south of the creek, along the south side of the marl workings is described in Section 31. Complete analytical results for sample M54 are given in the Appendix. A thicker section of undisturbed marl was not located, but T.W. Gibson (1901, p.16) reported an average of 13 feet. He also gives three analyses for the marl.

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 9 - Orangeville marl beds; Caledon Tp., Peel Co.
Marl was dredged by the Superior Portland Cement Co., 1907-1913. There is no marl in the adjoining lakes.

Section 31 | Orangeville Beds

Depth below surface (feet)	Description	Sample No.
0 - 2	Loam: Black, peaty.	
2 - 4	Marl: Buff-cream; dense; shells and organic matter not abundant.	M54
4 +	Sand: Grey; medium-grained.	

PERTH COUNTY

(67) Atwood, Elma Township

Marl underlies an area of low ground 5 miles south of Atwood in lots 24 and 25, concession XIII, Elma township, Perth county. Atwood is 6 miles southwest of Listowel. The marl deposit is accessible by gravel road, 2½ miles southeast of Highway No. 23.

Marl was dug from the deposit continuously during the years 1906-1913 and hauled to a plant at Atwood for the production of cement. Started as The Western Ontario Portland Cement Company, the company's name was changed to Maple Leaf Portland Cement Company in 1909. Gillespie (1905, p.162) describes the operation.

Originally marshland, the area is now fairly well drained and lightly wooded. The old workings occupy an area of 25 acres and constitute a series of shallow parallel trenches. Gillespie (1905, p.162) gives the area underlain by marl as 250 acres, and the section as follows:

Peat 2 - 5 feet
Marl 1½ - 12 feet
Clay to a depth of 30 feet.

The writer was unable to find a thick marl section in the area south of the road, 100 feet south of the workings. A 2-foot section of marly clay analysed 36.3 percent $CaCO_3$, 15.1 percent $MgCO_3$, 2.14 percent Fe_2O_3, and 51.16 percent insoluble. The complete section is shown in Section 32. Detailed analytical data for sample M70 are given in the Appendix.

Section 32 | Atwood Marsh

Depth below surface (feet)	Description	Sample No.
0 - 3	Soil: Black; peaty.	
3 - 5	Clay: Olive-buff; marly; rare shells.	M70
5 +	Clay: Grey; plastic; stoneless.	

PETERBOROUGH COUNTY

(68) Julian (Little Cedar) Lake, Burleigh Township

Julian Lake occupies parts of lots 7, 8, and 9, concession V, in the south part of Burleigh township, Peterborough county. Highway No. 28 touches its southernmost tip about 25 miles north of Peterborough city. Cottages are fairly numerous along the south, east, and north shores. The deposit has never been worked.

Julian Lake occupies an area of 220 acres. Water 3-4 feet deep overlies the marl in an irregular area of about 50 acres protruding into the lake from the west side. The water drops off sharply at the edge of the marl bars, and over much of its area the lake may be 6-10 feet deep.

White gastropod shells are common throughout the marl, and Chara debris is prominent in the upper part. Fibrous organic material is present in moderate amount. Ordovician limestone outcrops along the south shore of the lake. White Grenville marble outcrops along the west and north sides and occurs as a shoal near the centre of the lake. Outcrops of pink granite were noted on the east shore.

Julian Lake marl is of good uniform quality. A 13-foot section averaged 88.8 percent $CaCO_3$, 2.3 percent $MgCO_3$, 0.15 percent Fe_2O_3, and 0.52 percent insoluble. The dry powder is cream to pale grey in colour with a moderately high brightness and oil absorption. Natural particle size is 75 percent finer than 325 mesh, 52 percent finer than 10 micron. The crude marl averages 60.7 percent moisture; 650 pounds of dry marl can be extracted from one cubic yard of the crude.

A section sampled near the centre of the lake on a

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 10 - Julian (Little Cedar) Lake, Burleigh Tp., Peterborough Co. Note the marl shoals.

shallow marl bar is described in Section 33. Results of test work on the three samples are given in the Appendix.

Section 33 | Julian (Little Cedar) Lake

Depth below water (feet)	Description	Sample No.
0 - 4	Water.	
4 - 5	Marl: Cream-grey; very soft; abundant white gastropod shells.	
5 - 9	Marl: Grey-buff; soft; white gastropod shells common; minor fibrous organic material.	M12
9 - 13	Marl: Pale brown; soft; white gastropod shells common; increasing organic material.	M13
13 - 18	Marl: Grey-brown; soft; white gastropod shells common.	M14
18 - 19	Marl: Dark grey; rather dense; silty; shells scarce; minor organic material.	

(69) McGinnis Lake, Burleigh Township

McGinnis Lake is located in lot 6, concession XI, in the south part of Burleigh township, Peterborough county. It lies west of Jacks Creek, about 1½ miles north of the east end of Stoney Lake, and is accessible by a forest access road built by the Department of Lands and Forests in 1964. The lake is about 1 mile west of the Lakefield-Nephton road.

McGinnis Lake occupies an area of 14 acres. It is a deep, spring-fed lake in which marl is only observed in a narrow fringe along the south and east shores. Bedrock consists of high-calcium white marble of the Precambrian Grenville Series.

Chara debris is abundant in the marl, and gastropod shells are fairly common. Fibrous organic matter is present in moderate amount near the top of the section; finely-divided

organic matter is common near the base.

McGinnis Lake marl is of good quality. A 21-foot section, excepting a 3-foot impure zone near the middle, averages 91.9 percent $CaCO_3$, 1.4 percent $MgCO_3$, 0.15 percent Fe_2O_3, and 0.61 percent insoluble. The dry powder is pale grey with a moderately low brightness. Oil absorption is moderate. Natural particle size is 78 percent finer than 325 mesh, 56 percent finer than 10 micron. The crude marl has a moisture content of 50.9 percent; 805 pounds of dry marl can be extracted from one cubic yard of the crude.

A section sampled 100 feet from shore at the edge of the marl shelf in the northeast part of the lake is described in Section 34. Complete analytical results for samples M38, M39 and M40, are given in the Appendix. Increasing density of the marl prevented penetration greater than 28 feet, where sampling was stopped still in marl.

Section 34	McGinnis Lake		
Depth below water (feet)		Description	Sample No.
0 - 3	Water.		
3 - 7	Marl:	Pale grey; very soft.	
7 - 17	Marl:	Pale grey to pale brown; soft; occasional shells; moderate content of fibrous organic matter.	M38
17 - 20	Marl:	Grey-brown; very soft; high organic content.	
20 - 24	Marl:	Buff-grey; soft; occasional shells.	M39
24 - 28	Marl:	Olive-buff; moderately dense; shells common; some finely-divided organic matter.	M40

(70) Buckley Lake, Douro Township

Buckley Lake occupies part of lots 14-16, concessions V and VI, Douro township, Peterborough county. A secondary road from Lakefield follows the line between concessions VI

and VII, passing west of the lake about ½-mile distant. Access to the lake may be obtained via a private road in lot 17, concession VI, or by canoe along the creek that drains from the south end of the lake.

Marl was dredged from Buckley Lake during the years 1902-1914, and used for cement at a plant in Lakefield. The Lakefield Portland Cement Company was merged in 1909 to form plant No. 7 of Canada Cement Company Limited. The operation is described by Gibson (1903, p.31) and Gillespie (1905, p.148 and 183).

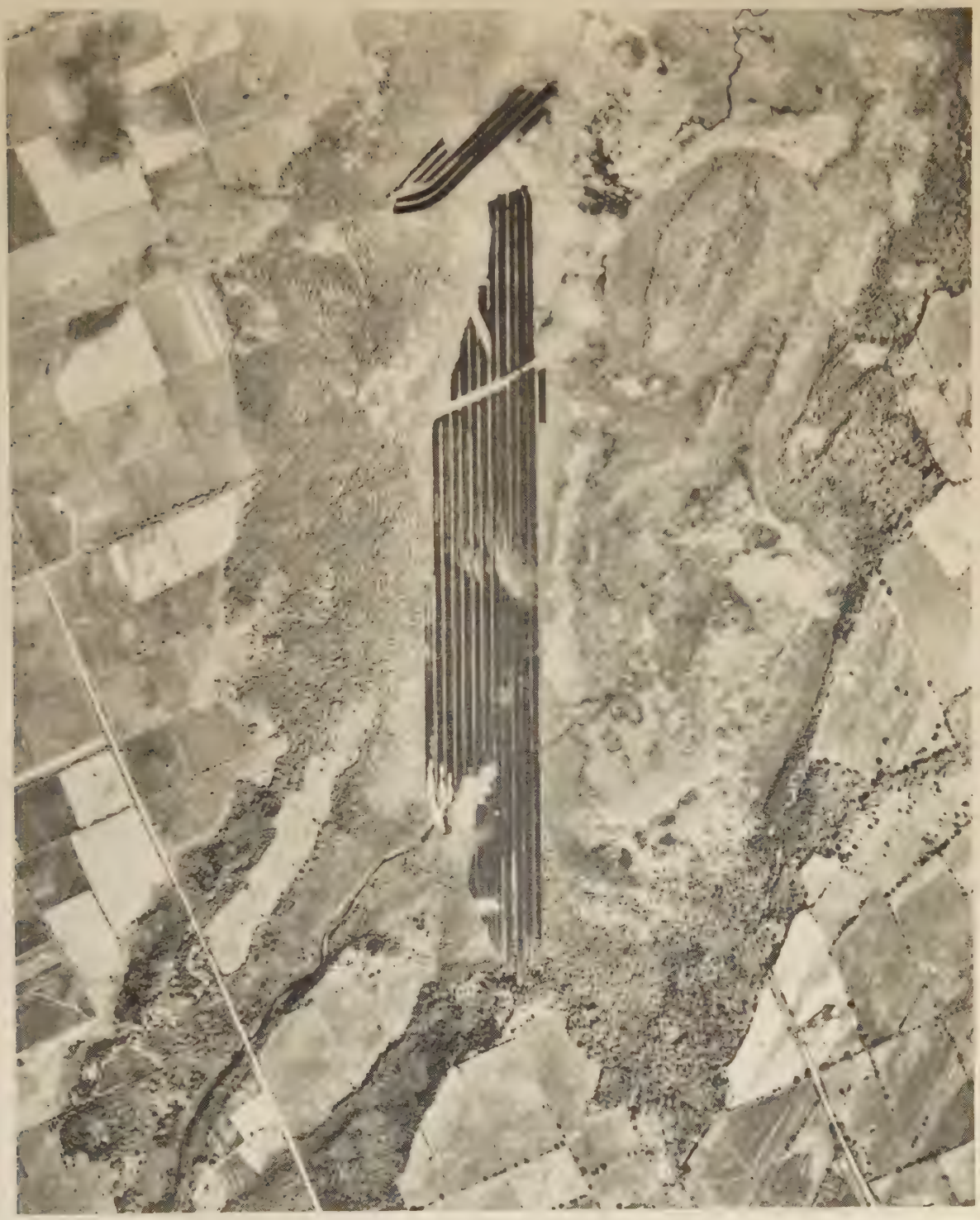
Buckley Lake is a large marsh area occupying much of the north part of Douro township. Parallel dredged channels along the west side occupy an area of 110 acres. Reserves of marl northeast of these workings are probably very large. Buckley Lake was drained at the time the marl was being excavated, and open water is now restricted to the old dredged channels; the rest is an open grass and cane marsh in which 1-2 feet of fibrous peaty material overlies the marl.

Shells, both gastropods and pelecypods, occur in moderate amount and Chara debris is common in the upper part. Fibrous organic material is present in minor amount. Sand underlies the marl, and the lower marl strata are sometimes seriously contaminated by grains of quartz and mica. Ordovician limestone is the bedrock throughout the area.

The marl of the Buckley Lake deposit is of rather poor quality because of sand contamination and colour. An arithmetic average of three samples gave 75.8 percent $CaCO_3$, 0.5 percent $MgCO_3$, 0.55 percent Fe_2O_3, and 4.31 percent insoluble. Another sample was excluded from the average because of excessive sand contamination. Colour of the dry powder is grey with very low brightness. Oil absorption is moderate. The crude marl averages 70.0 percent moisture; 500 pounds of dry marl can be extracted from a cubic yard of the crude.

The marl was tested at three locations along the east side of the dredged area. At location No. 1, approximately midway along the old workings, soft fluid marl beneath a surface crust graded into sand at a depth of about 10 feet. Location No. 2 was 2,000 feet north of No. 1 and 150 feet east of the old workings. Location No. 3 was 100 feet east of the northeast end of the main workings. The sections at location No.'s 2 and 3 are described in Section 35. Complete analytical results for samples M15, M16, M17, and M18 are

Courtesy Ontario Dept. Lands and Forests.



1 inch = ¼ mile; north is to the top.

Photo 11 - Buckley Lake, Douro Tp., Peterborough Co. A well-planned marl dredging operation that served the cement plant at Lakefield, 1902-1914.

given in the Appendix.

Section 35 | Buckley Lake

Location No. 2

Depth below surface (feet)	Description	Sample No.
0 - 1	Fibrous peat.	
1 - 8	Marl: Cream-grey grading downwards through pale brown to dark brown; soft; shells common; some fibrous organic material.	M15
8 - 15	Marly sand: Medium grey; dense; shells and organic material scarce.	M16
15 +	Sand.	

Location No. 3

Depth below surface (feet)	Description	Sample No.
0 - 2	Grass and sedge peat.	
2 - 9	Marl: Cream-grey; soft; low content of shells and organic material.	M17
9 - 14	Marl: Pale brown grading downwards to dark brown; shells common; fibrous organic material scarce.	M18
14 +	Sand: Grey; marly.	

(71) Sandy Lake, Harvey Township

Sandy Lake lies 4 miles west of Buckhorn and occupies most of lots 6-12, concession XI-XII, Harvey township, Peterborough county. Marl underlies most of the lake and is

particularly common at the north end. The lake supports a considerable cottage community.

(72) White Valley Deposit, Harvey Township

Marl underlies a small lake and marsh in lot 31, concession XVIII, Harvey township, Peterborough county. The deposit is located in the northwest part of the township, 7 miles north of Bobcaygeon. It is one of the few Ontario deposits that has been worked as a source of industrial filler.

Five claims were staked in 1934, and White Valley Mines Limited was formed to develop the property. The company's name was changed to White Valley Chemicals Limited in 1939, and in 1940 900 tons of whiting were sold for $9,600 (Satterly, 1943, p.55). The property was purchased by Chem-Ore Mines Limited in 1944, but no further production is recorded. A plant was constructed on the property to produce 50-80 tons of product per day, using banks of infra-red lamps for drying. A detailed description of the plant is given by D.C. McLaren (1945). Only the foundation of the plant remained in 1965.

The lake is uniformly shallow, mostly less than 2 feet deep, and long cane reeds are common over most of its surface. The area of the lake is 45 acres, but marl may also underlie the low wooded shores at the north end.

Shells are moderately common throughout the deposit, and finely-divided organic matter is responsible for the brown colour of the crude marl. Limestone of the Trenton-Black River Groups is the bedrock; it outcrops near the plant site at the south end of the lake.

Crude marl sampled near the centre of the lake is of good chemical quality, but is off colour due to organic matter. A 13-foot section analysed 89.9 percent $CaCO_3$, 1.1 percent $MgCO_3$, 0.09 percent Fe_2O_3, and 0.58 percent insoluble. The dry powder is pale grey with a low brightness. Oil absorption is high. Natural particle size is 50 percent finer than 325 mesh, 27 percent finer than 10 micron. The crude marl contains 72.4 percent water; 465 pounds of dry marl can be extracted from one cubic yard of the crude.

A small area on the southeast shore of the lake, near the plant site, is underlain by 12-18 inches of dense white marl

Courtesy Ontario Dept. Lands and Forests

1 inch = ½ mile; north is to the top.

Photo 12 - White Valley deposit, Harvey Tp., Peterborough Co. In 1940 a small amount of marl was produced for filler purposes in the plant at the southeast end of the deposit.

resting on a hard surface. This appears to be the site of a stockpile of crude marl; the marl is of high quality, but the presence of shells suggests that no further beneficiation has taken place than might be expected by the natural washing of a dredged stockpile. A sample (M62) analysed 94.9 percent $CaCO_3$, 1.5 percent $MgCO_3$, 0.08 percent Fe_2O_3, and 0.46 percent insoluble. The dry powder is white with a high brightness. Oil absorption is moderately low. The particle size is 94 percent finer than 325 mesh, 75 percent finer than 10 micron.

The marl section was sampled near the centre of the lake. The measured section is described in Section 36. Complete analytical results for samples M61 and M62 are given in the Appendix.

Section 36 | White Valley Deposit

Depth below water (feet)	Description	Sample No.
0 - 2	Water.	
2 - 5	Marl: Very soft.	
5 - 18	Marl: Pale brown to grey; soft; moderate shell content; minor amount of finely-divided organic matter.	M61
18 - 18½	Gyttja and sand: Several inches of brown gyttja on fine-grained sand and silt.	

PRESCOTT COUNTY

(73) Hawkesbury, West Hawkesbury Township

W.E. Logan (1863, p.765) mentions a deposit in a meadow on lot 18, concession IV, West Hawkesbury township, Prescott county:

"It is known to cover three or four acres, but is supposed to be much more extensive. At the place which has been excavated, the marl is three and a half feet in thickness, and is covered by four feet of peat. Branches and trunks of

trees, in a good state of preservation, are met with in the marl, but not in the overlying peat."

RAINY RIVER DISTRICT

According to W.G. Miller (1904, p.100) marl deposits occur in the district. No precise locations are mentioned.

RENFREW COUNTY

(74) Blackbird Lake, Brougham Township

A deposit of marl in Blackbird Lake, 6 miles southwest of Mount St. Patrick, in mentioned by J. Satterly (1944, p.67). The lake is small, and occupies lot 20, concession XI, Brougham township, Renfrew county.

(75) Green Lake, Brougham Township

Marl is mentioned in Green Lake, 2½ miles north of Black Donald Mines (J. Satterly 1944, p.67). The lake is about 1 mile long by ½-mile wide. It occupies part of lots 14-17, concession VII, Brougham township, Renfrew county.

(76) Limestone Lake, Brougham Township

A deposit of marl in Limestone Lake, 7 miles west of Calabogie, is mentioned by J. Satterly (1944, p.67). The lake occupies part of lots 1-3, concession IV, Brougham township, Renfrew county.

(77) Marly Lake, Brougham Township

Marl occurs in a small lake known as Marly Lake, 2½

miles southwest of Mount St. Patrick (Satterly, 1944, p.67). Marly Lake lies in lot 9, concession XII, Brougham township, Renfrew county.

(78) Moran Lake, Brougham Township

J. Satterly (1944, p.67) mentions marl in Moran Lake, 5 miles southwest of Mount St. Patrick. The lake is narrow and occupies part of lots 17-19, concession XII, Brougham township, Renfrew county.

(79) West Perrault Lake, Grattan Township

West Perrault Lake occupies parts of lots 25-30, concessions XI-XII, Grattan township, Renfrew county. It lies about 7 miles southwest of Eganville, and is accessible on the north side by private road owned by Mr. Ray Kruger of Eganville. Access may also be possible through farms at the east end.

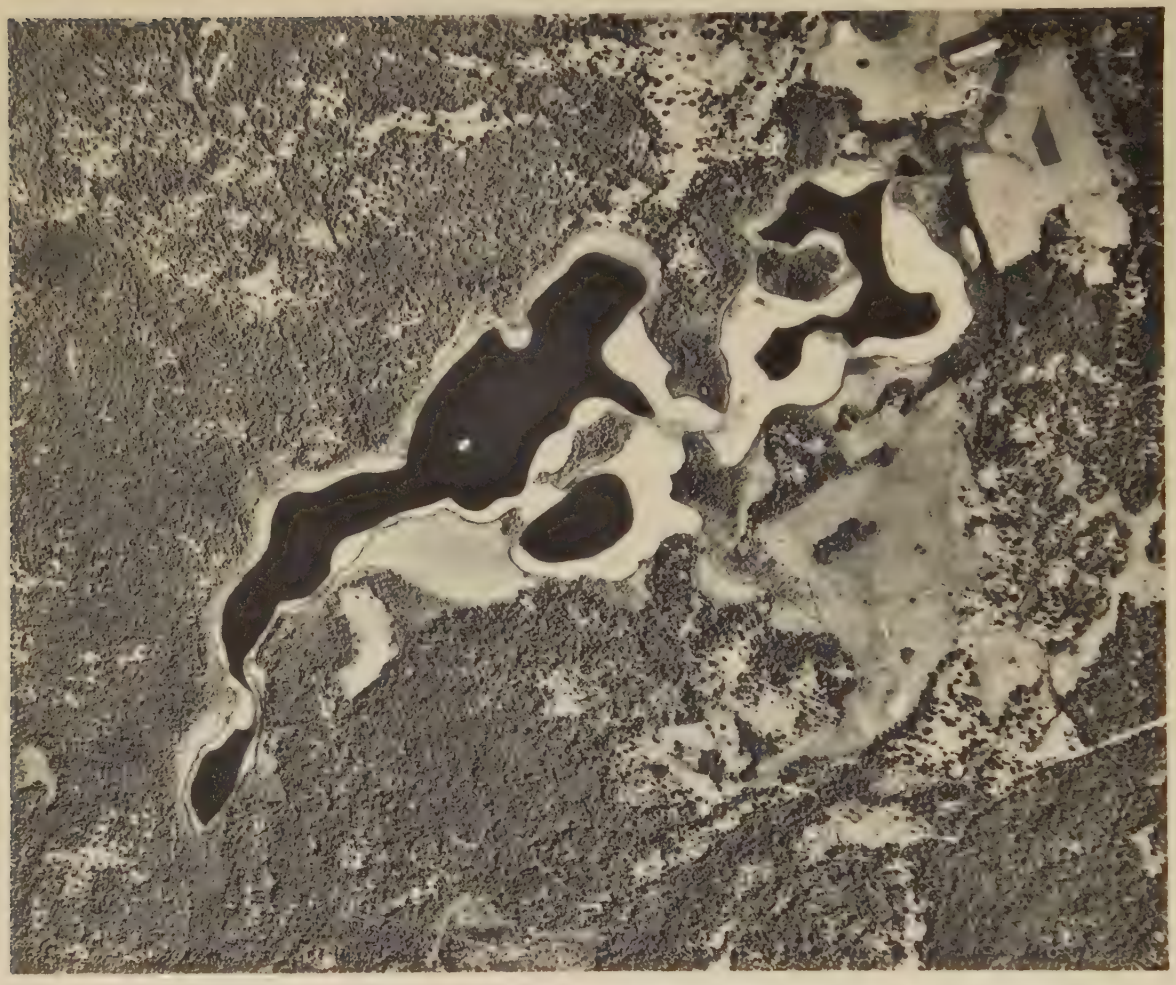
West Perrault Lake occupies an irregular area of 160 acres. The lake is deep except in the east half where broad marl shoals are common. The terrain is rough, and the bedrock consists of granitic and metasedimentary rocks, including marble.

Shells are not especially common in the marl, although a large variety of species are recognized. Roots, and finely divided organic matter, are not abundant.

The marl of West Perrault Lake is of good quality. A 15-foot section averaged 92.0 percent $CaCO_3$, 2.2 percent $MgCO_3$, 0.15 percent Fe_2O_3, and 0.62 percent insoluble. The dry powder is pale grey with a moderately low brightness. Oil absorption is moderate. Natural particle size is 81 percent finer than 325 mesh, 58 percent finer than 10 micron. The crude marl contains 63.5 percent water; 610 pounds of dry marl are contained in one cubic yard of the crude. Chemical quality is best at the top of the section, decreasing slightly with depth.

The marl was sampled several hundred feet off the south shore in the eastern part of the lake. Increasing density of the marl prevented sampling below a depth of 19 feet. The section is outlined in Section 37, and complete analytical data for samples M66 and M67 are given in the Appendix.

Courtesy Ontario Dept. Lands and Forests



1 inch = ¼ mile; north is to the top.

Photo 13 - West Perrault Lake; Grattan Tp., Renfrew Co.
Note the prominent marl fringe.

Section 37	West Perrault Lake	
Depth below water (feet)	Description	Sample No.
0 - 2	Water.	
2 - 4	Marl: Grey; soft.	
4 - 12	Marl: Yellow-grey becoming buff-grey; soft; minor shells and roots.	M66
12 - 19+	Marl: Cream-grey changing to olive-brown with depth; dense; occasional shells.	M67

(80) Wilson Lake, Matawatchan Township

Marl is reported (Floyd Rutledge, personal communication) in Wilson Lake, 10 miles southeast of Griffith and 1¼ miles north of the Madawaska River. Wilson Lake occupies part of lots 13-14, concession XI, Matawatchan township, Renfrew county.

(81) White Lake, McNab Township

Marl underlies the eastern part of White Lake in parts of lots 1-8, concessions I-III, McNab township, Renfrew county. The settlement of White Lake is located 9 miles west of Arnprior, and access to the lake is most easy at a public landing at nearby Norway Point.

White Lake is not a typical marl lake. It is a large lake lacking obvious marl shoals; the marl is pinkish in colour and the bed is thin. Logan (1863, p.765) describes it as follows:

"In the lower part of White Lake .... about seven hundred acres are covered with marl, which was found to have a depth of from five to seven feet, and was covered by not more than two or three feet of water."

A few large gastropod shells are found in the marl. The lake lies along the contact between predominantly granitic

rocks to the northwest and marble and paragneiss to the southeast.

White Lake marl is of fair quality, although less pure than many other Renfrew county deposits. A 4-foot section analysed 86.6 percent $CaCO_3$, 3.0 percent $MgCO_3$, 0.44 percent Fe_2O_3, and 1.24 percent insoluble. The dry powder is pale grey with a rather low brightness. Oil absorption is high. Natural particle size is 65 percent finer than 325 mesh, 50 percent finer than 10 micron. The crude marl contains 79.1 percent water; 350 pounds of dry marl are contained in one cubic yard of the crude.

The marl section was sampled off Norway Point about midway between the shores. The lake is uniformly shallow, and contains scattered cane reeds. The section is given in Section 38. Detailed analytical results for sample M68 are given in the Appendix.

Section 38 | White Lake

Depth below water (feet)		Description	Sample No.
0 - 5	Water.		
5 - 9	Marl:	Pale brown to pink; very soft; occasional large yellow shells.	M68
9 +	Clay:	Grey; gritty.	

(82) Green Lake, Ross Township

Marl occurs in Green Lake, lot 13, concession II, Ross township, Renfrew county. According to R.W. Ells (1902, p.65): ".... the marl is found along the shores of the lake, in one place with an exposed extent of five acres, and a depth of from five to twelve feet, and also along the southeast shore of the lake over a space of ten acres, having about the same thickness."

(83) Olmsted Pond, Ross Township

According to R.W. Ells (1902, p.65) marl occurs in a pond at the northwest tip of Olmsted Lake, on lot 15, concession II,

Ross township, Renfrew county. He describes it thus: "... the marl is found banked up four to five feet near the outlet of the lake, extending for several hundred yards, and probably underlying the water of the lake."

(84) Clear Lake, Sebastopol Township

Marl is reported to occur in Clear Lake and in the small neighbouring ponds (W.E. Logan 1863, p.765). Clear Lake is a large lake occupying part of lots 16-32, concessions VII-XII, Sebastopol township, Renfrew county. Cottages are common along the northwest side, and marl is not especially obvious except in a bay near the east end of the lake.

(85) Coulonge Lake Marsh, Westmeath Township

G.C. Hoffmann (1894, p.27-28) describes a small occurrence near Coulonge Lake, an enlargement of the Ottawa River 12 miles east of Pembroke: "It consists of two distinct, layers - an upper dark coloured layer, twenty-two inches thick; and a lower light coloured layer, fourteen inches thick."

Analyses of the two layers are reproduced in part as follows:

	Upper layer Percent	Lower Layer Percent
CaO	52.31	51.68
$CaCO_3$ (calculated)	93.41	92.28
MgO		0.51
Insoluble	0.88	4.06

The occurrence is located in lot 12, concession A Coulonge Lake Front, Westmeath township, Renfrew county.

(86) La Passe, Westmeath Township

A small lake near the Ottawa River, 16 miles east of

Pembroke, is reported by R.W. Ells (1902, p.65) to contain marl. The occurrence is said to be in lots 9-10, East Front B, Westmeath township, Renfrew county, which is 1½ miles south of La Passe.

(87) Mink Lake, Wilberforce Township

Mink Lake occupies part of lots 4-11, concessions VIII-X, Wilberforce township, Renfrew county. It is a large marl lake lying about 3 miles east of Eganville. It is readily accessible by road along its west side.

Mink Lake occupies an area of more than 1,000 acres. The entire lake is probably underlain by marl, but broad marl shoals are particularly noticeable in a 230-acre area at the northwest end. Here the depth of water is not excessive and cane reeds are thinly distributed across the shoals.

A wide variety of gastropod shells are present, and pelecypod shells and Chara debris are common. An outlier of Paleozoic limestone forms the bedrock of Mink Lake.

Mink Lake marl is of fair quality although the colour darkens with depth. In the 15½-foot section sampled the upper half is of better chemical quality then the lower. Average chemical composition for the complete section is 88.4 percent $CaCO_3$, 1.7 percent $MgCO_3$, 0.10 percent Fe_2O_3, and 1.10 percent insoluble. The dry powder is buff with a low to moderate brightness. Oil absorption is high. The natural particle size is 85 percent finer than 325 mesh, 64 percent finer than 10 micron. The crude marl is 66.9 percent water; 550 pounds of dry marl are contained in one cubic yard of the crude.

The marl section was sampled about 800 feet off-shore at the northwest end of the lake. The section is shown in Section 39, and complete analytical results for samples M64 and M65 are given in the Appendix.

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 14 - Mink Lake, Wilberforce Tp., Renfrew Co.
The photograph shows the west end of the lake, where marl is prominent in broad shoals and fringes.

Section 39 | Mink Lake

Depth below water (feet)	Description	Sample No.
0 - 3	Water.	
3 - 10	Marl: Brown-grey; soft; moderate content of white shells.	M64
10 - 18½	Marl: Medium brown; dense; moderate content of shells.	M65
18½ +	Clay: Grey; stoneless.	

SIMCOE COUNTY

(88) Wasaga Pond, Flos Township

A marl pond 2 miles east of Wasaga Beach is located in lots 24-25, concession VII, Flos township, Simcoe county. Access to the pond is by gravel road for a distance of about 1 mile south from highway No. 92.

The pond, and an extensive marsh area to the south, covers an area of 250 acres. The pond is reedy and uniformly shallow. A golf course has been developed along the northwest side; elsewhere the area is open farmland. The pond lies just beyond the strands of beach and dune sands that fringe the foot of Nottawasaga Bay. Limestone of the Trenton and Black River Groups is the bedrock.

The marl is brown-coloured due to finely-divided organic matter. Roots are scarce, but pelecypod and gastropod shells are common.

Wasaga marl is of poor quality. A 9-foot section analysed 81.9 percent $CaCO_3$, 0.9 percent $MgCO_3$, 0.43 percent Fe_2O_3, and 4.32 percent insoluble. The dry powder is grey-coloured and of very low brightness. Oil absorption is moderate. Natural particle size is 54 percent finer than 325 mesh, 34 percent finer than 10 micron. The crude marl contains 77.3 percent water; 380 pounds of dry marl are available in one cubic yard of the crude.

The pond was sampled just off the marsh area on the south

side. The section is given in Section 40. Complete analytical results for sample M72 are given in the Appendix.

Section 40 | Wasaga Pond

Depth below water (feet)	Description	Sample No.
0 - 3	Water.	
3 - 12	Marl: Brown; soft to dense; shells common.	M72
12 - 13	Clay: Grey; soft, smooth.	
13 +	Sand: Grey; medium-grained.	

(89) Orillia, Orillia Township

R.E. Deane (1950, p.41) reports that "The only deposit of marl seen in the Lake Simcoe area lies 3 miles north of Orillia. The marl is greyish white, and from 3 to 4 feet thick."

DISTRICT OF SUDBURY

(90) Surprise Lake, Garnet Township

According to R.C. Emmons and E. Thomson (1929, p.27) marl occurs in Surprise Lake, Garnet township, District of Sudbury.

(91) Betty Lake, Tooms Township

Marl occurs in Betty Lake and two small lakes to the west in the northeast quarter of Tooms township, District of Sudbury. Analysis of a sample from the first lake west of Betty Lake is given by R.C. Emmons and E. Thomson (1929, p.28) as follows:

	Percent	
CaO	45.40	Calculated $CaCO_3$ = 81.07%
MgO	1.23	Calculated $MgCO_3$ = 2.58%
Fe_2O_3	0.07	
Al_2O_3	0.03	
CO_2	36.92	
Insoluble	8.40	
Ignition loss	8.20	(Moisture and organic matter)
	100.25	

(92) Marl Lake, Whigham Township

Marl Lake is indicated by W.D. Harding (1937, map 46a) on the mutual boundary between Whigham and Silk townships in the District of Sudbury. The lake is drained to the northeast by Marl Creek, flowing ultimately into Horwood Lake in Horwood township.

DISTRICT OF THUNDER BAY

W.G. Miller (1904, p.111) makes general reference to marl occurrences in the District of Thunder Bay as follows: "The marl deposits, such as those which are found in some of the small lakes along the line of the Port Arthur, Duluth and Western Railway, are likely to be of economic value in the future, other forms of limestone being comparatively scarce."

(93) Shillabeer Creek, Cockeram Township

Marl occurs in the bed of Shillabeer Creek in Cockeram township, and in Shillabeer Lake and adjoining low ground in the undivided territory west of Cockeram township, District of Thunder Bay. The Shillabeer area is south of Lake Nipigon, and 20-25 miles by road north of Hurkett. A road trending west from the Hurkett-Armstrong highway crosses the creek and follows the south shore of Shillabeer Lake.

Shillabeer Lake, then known as Sucker Lake, is described by A.W.G. Wilson (1910, p.116) as follows:

"The average depth of the lake at the time of our visit (September, 1901) was about 12" or 14". The maximum depth that we noted in a number of soundings along what seemed to be a stream channel was 6 feet, but over the greater part of the lake the depth was between 6" and 8". In many places it was impossible to reach the shore at all, and for several miles in our course around the lake the canoe was forced through the slime forming the bed of the lake. The water had a somewhat sulphurous taste and disagreeable odour due to the decomposition of a species of Chara, which everywhere is found growing over the bottom. The depth of the deposit of marl now forming was not ascertained, though it is certainly over 6 feet. The material seems to consist of calcareous casts of Chara sp. mingled with carbonaceous material."

During the winter of 1960 The Anaconda Company (Canada) Limited is reported to have drilled some 400 holes and indicated a large tonnage of marl (M.E. Coates, personal communication).

The quality of the marl is generally good. The results of testwork on samples submitted by W.S. Miners of Fort William and Fred Koosel of Port Arthur are detailed in the Appendix (samples M49 and M73 respectively).

In 1967 M.E. Coates sampled the deposit for the Ontario Department of Mines. Three samples were taken by hand auger 1½ miles downstream from the road. The samples represent sections from 2 to 6 feet below creek bed taken at points 400 feet apart. Results of analytical studies by the Laboratory Branch, Ontario Department of Mines, are given in Table 7.

Average moisture content of the three samples was 46.7 percent; 880 pounds of dry marl are contained in one cubic yard of the crude. Particle size analyses were not performed on these samples. On samples received from Messrs. Koosel and Miners, about 77 percent was finer than 325 mesh, 50 percent finer than 10 micron.

Shillabeer marl contains abundant fragments of the alga Chara. One species of pelecypod, and most of the normal gastropods, are also present. Bedrock in the area consists of Proterozoic sedimentary rocks of the Sibley Group, some of which are dolomites, calcareous shales, and siltstones.

Table 7 | Shillabeer Creek Marl - M. E. Coates samples

	GM-1 percent	GM-2 percent	GM-3 percent
CaO	51.50	41.30	50.40
MgO	0.96	1.60	0.98
Fe_2O_3	0.13	1.57	0.17
Loss on ignition	45.29	36.42	44.95
Insoluble	1.45	16.27	1.33
Total	99.33	97.16	97.83
Calculated $CaCO_3$	92.00	73.70	90.00
Calculated $MgCO_3$	2.00	3.34	2.02
Total carbonate	94.00	77.04	92.02
Brightness	62.0	53.5	65.0
Oil absorption	31.3	30.9	37.4

(94) Red Paint Lake, Gzowski Township

Red Paint Lake is 7 miles west of Kowkash, in the southeast corner of Gzowski township, east of Lake Nipigon in the District of Thunder Bay. A description of the lake and its marl bed is given by E.S. Moore (1909, p.252):

"Red Paint lake is fed entirely by springs issuing from the drift beneath its surface, as no superficial stream can be seen entering this lake. The name seems inappropriate for the lake, as the water is a charming, deep blue color. This color seems to be due to the lack of earthy sediments in the water and possibly to the presence of white calcium carbonate on the bottom and disseminated through the water. This white sediment must have an influence on the absorption of the rays of light and in the production of the blue color, because Blue lake, in the southern portion of the district, contains some of this sediment and is also remarkably blue. No other lake in the region possesses a similar deposit or anything like such a blue color. The deposit of calcium carbonate, or travertine, in Red Paint lake is at least 20 feet deep at the southeastern end, as a pole can be thrust down into it to that depth. Around other portions of the lake the deposit

varies greatly in thickness and may even be lacking. The creek leaving the lake is so saturated with calcium carbonate that it deposits travertine on the roots and stems of plants along its course, and on the bottoms of the upper lakes of the Red Paint river."

(95) Chara Lake, Kowkash Township

According to L.F. Kindle (1931, p.86), "White marl is abundant on the bottom of Chara Lake. It is associated with a prolific Chara (algae) reef in the west half of the lake."

Chara Lake is 5 miles north of Kowkash in the east-central part of Kowkash township, east of Lake Nipigon in the District of Thunder Bay.

(96) Intola, McIntyre Township

T.L. Tanton (1931, p.201) describes a small deposit 10 miles northwest of Fort William as follows:

"A lake with an area of about 12 acres occurs in McIntyre township, 1 1/3 miles south-southeast of Intola post office. A deposit, locally 2 feet thick, consisting chiefly of calcareous shells of small organisms, is exposed along the shore around the western part of the lake. The deposit probably extends over a large part of the lake bottom."

(97) Wawong Lake, Rupert Township

Wawong Lake lies 10 miles east of Kowkash in the southeast corner of Rupert township, District of Thunder Bay. L.F. Kindle (1931, p.86) refers to marl ".... in Wawong and nearby lakes which are characterized by a clear blue-green colour."

(98) Blue Lake, Suni Township

E.S. Moore (1909, p.252) refers to marl in Blue Lake, 8 miles southwest of Kowkash, in the west central part of Suni township, District of Thunder Bay.

(99) Tashota

P.E. Hopkins (1917, p.215) mentions marl ".... in a small pond half a mile to the southwest of the Tashota gravel pit." Tashota is located on the C.N.R. east of Lake Nipigon, in undivided territory in the District of Thunder Bay.

DISTRICT OF TIMISKAMING

(100) Davis Lake, McEvay Township

Davis Lake straddles the McEvay-Tolstoi boundary in the District of Timiskaming, Larder Lake mining division. Marl underlies a small bay near the northwest end of the lake, in McEvay township near the 4-mile boundary post. The lake is accessible via unsurfaced road, about 15 miles south from Matheson.

The deposit has been considered as a source of lime for a cement industry in northeastern Ontario, and it was drilled by the Quebec Government to determine its value for agricultural lime for farmlands in western Quebec (S.A. Ferguson, personal communication). There has been no production.

Except for a shallow shoreline along the east side, Davis Lake is deep. Marl was found only in a shallow bay, 15 acres in area, at the northwest end of the lake. Only coarse brown sand was encountered with the sampler in all other parts of the lake, and the writer doubts that any marl underlies the main body of the lake.

Shells are scarce in the marl, although a few fragments of gastropods and pelecypods were noted. Fibrous carbonaceous material is common. Granitic rocks outcrop on the east side of the lake but in general the area is uniformly drift-covered.

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 15 - Davis Lake, McEvay Tp., District of Timiskaming. Davis Lake is predominantly sandy. Marl only underlies the small bay at top left centre.

Davis Lake marl is of good quality. The two sections sampled averaged 86.5 percent $CaCO_3$, 1.7 percent $MgCO_3$, 0.31 percent Fe_2O_3, and 1.89 percent insoluble. The dry powder varies from cream to pale grey in colour with moderate brightness. Oil absorption is high. The crude marl averages 65.0 percent moisture; 580 pounds of dry marl can be extracted from a cubic yard of the crude.

Two locations were sampled in the small bay underlain by marl: Location No. 1 was at the east end of the small island in the mouth of the bay where it opens into the main body of the lake; Location No. 2 was located 200 feet east of the mouth towards the centre of the bay. These locations are described in Section 41. The results of test work on the three samples (M4 M5, and M6) are given in the Appendix.

Section 41 | Davis Lake

Depth below water (feet)		Description	Sample No.
Location No. 1:			
0 - 2½	Water.		
2½- 7	Marl:	Cream-grey, becoming pink-grey and green-grey towards bottom; soft; minor shells; fibrous organic material common.	M4
7 +	Sand.		
Location No. 2:			
0 - 3	Water.		
3 - 10	Marl:	Pale brown; soft; rare shell fragments; moderate amount of fibrous organic material.	M5
10 - 16	Marl:	Pale brown; soft; shells scarce; moderate content of fibrous organic material.	M6
16 +	Clay:	Grey; soft; stoneless.	

(101) Twin Lakes, Thorneloe Township

Marl underlies a pond in west-central Thorneloe township, District of Timiskaming, Porcupine mining division. It is located on the east side of an unsurfaced road about 4 miles south of highway No. 101, some 15 miles southwest of Timmins. The occurrence lies on the proposed route of the Sudbury-Timmins highway.

In October 1957 Gerard Senecal removed 71 cubic yards of marl using a dragline at the north end of the easternmost lake. Three parallel channels were excavated measuring 40 by 90 feet, 25 by 130 feet, and 40 by 130 feet. Most of the excavated material is piled alongside; only minor shipments for test purposes were made.

Marl does not appear to be present in the pond west of the road, and it is erratically distributed in the larger pond east of the road. The sampler encountered marl to a depth of 16 feet in one place; in other places only sand was encountered. The east pond occupies an area of 38 acres, not including a small island in the north-central part, and much of it is undoubtedly underlain by marl. Marl may also underlie low open ground to the northeast.

Only minor amounts of fragmented shells are present, and the content of fibrous organic material varies from moderate to common. Bedrock is composed of basic volcanic rocks and interflow sedimentary rocks (Ontario Dept. of Mines, Map 2046), and a uniform cover of sandy drift characterizes the region.

The marl is generally of good quality. An arithmetic average of five samples taken at random points gave 87.0 percent $CaCO_3$, 2.2 percent $MgCO_3$, 0.28 percent Fe_2O_3, and 1.83 percent insoluble. The dry powder is buff or buff-grey in colour with a moderate brightness. Oil absorption is moderate. The crude marl averages 56.5 percent water; 720 pounds of dry marl can be extracted from one cubic yard of the crude.

The lake east of the road was tested at various points with the marl sampler. Results of testwork on the samples described below are given in the Appendix.

At the extreme southeast corner of the lake 13 feet of marl underlies 3 feet of water and overlies medium-grained grey sand. The upper 7 feet of the marl is a soft brown organic material in which shells and fibrous matter are common.

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 16 - Twin Lakes, Thorneloe Tp., District of Timiskaming. In 1957 a small amount of marl was excavated in the mouth of the creek at the north end of the deposit.

The bottom 6 feet is a grey-buff marl represented by sample M8.

Sample M7 represents 3½ feet of olive-coloured marl in which roots are common, underlying 1½ feet of water and overlying 1 foot of grey silt followed by sand at a point 500 feet north of the previous location.

In a bay midway up the east side of the lake 6 feet of buff marl containing some fibrous organic matter underlies 3 feet of water and overlies ½ foot of grey silt followed by sand. Sample M9 represents the marl.

Along the north shore of the lake marl was encountered at some points but only sand at others. At the mouth of the river channel, 5 feet of buff marl underlies 3 feet of water and overlies grey silt and sand. Sample M10 represents the marl at this point.

The old marl workings are located in a marsh area 200 yards upstream from the river mouth. The dredged channels were bottomed in sand at a moderate depth. Sample M11 is a bulk sample taken at random from the excavated marl piled alongside.

VICTORIA COUNTY

(102) Raven Lake, Bexley Township

Raven Lake lies in lots 3 and 4, concessions II and III, Bexley township, Victoria county. It is west of Balsam Lake, 2½ miles north of highway No. 46, and 8 miles west of Coboconk. A CNR spur line to Coboconk lies along the southeast shore. The south side of the lake is accessible by road along the line between concessions II and III.

Marl was dredged from Raven Lake by The Raven Lake Portland Cement Company, 1904-1908, and The Kirkfield Portland Cement Company, 1909-1914. The plant and workings were on the south side, adjacent to the track. Clay was brought by rail from Beaverton. The operation is described by Gibson (1903, p.32-33) and Gillespie (1905, p.157-159).

Raven Lake occupies an area of 285 acres. Marl underlies most of the lake beneath 3-5 feet of water, except for a dredged area of 25 acres adjoining the old cement plant on the

Courtesy Ontario Dept. Lands and Forests

1 inch = ¼ mile; north is to the top.

Photo 17 - Raven Lake, Bexley Tp., Victoria Co.
Raven Lake is almost completely marl-filled. The small areas of dredging supplied marl for the cement plant on the southeast shore.

southeast shore. Low ground east, west, and north of the open water may extend the area underlain by marl to 800 acres. Dredged channels in low ground off the south tip of the lake occupy an area of 10 acres.

Shells are common in the marl; gastropods predominate, but in the upper part ostracods and debris of the alga Chara are common. Carbonaceous matter is scarce. Ordovician limestone outcrops nearby.

Raven Lake marl is of fair quality. A 17-foot section averaged 81.8 percent $CaCO_3$, 2.7 percent $MgCO_3$, 0.17 percent Fe_2O_3, and 2.38 percent insoluble. The dry powder is pale grey with a low brightness. Oil absorption is moderately high. The crude marl averages 67.2 percent water; 550 pounds of dry marl can be extracted from a cubic yard of the crude.

A section sampled at the south end of the lake, approximately midway between the two dredged areas, is described in Section 42. Results of test work on the three samples (M1, M2, and M3) are given in the Appendix.

Section 42 | Raven Lake

Depth below water (feet)	Description	Sample No.
0 - 3	Water.	
3 - 12	Marl: Pale brown, pink at surface; soft; shells common; fibrous organic material scarce.	M1
12 - 15	Marl: Grey; moderately dense; shells and fibrous organic material scarce.	M2
15 - 20	Marl: Pale brown; moderately dense; occasional shells; fibrous organic material scarce.	M3
20 +	Rock.	

(103) Manilla, Mariposa Township

A deposit at Manilla, 12 miles west of Lindsay, in Mariposa township, Victoria county, is mentioned by W.G. Miller (1904, p.114). His analysis is reproduced in part, as follows:

	Percent	
CaO	53.27	Calculated $CaCO_3$ = 95.09%
MgO	0.77	Calculated $MgCO_3$ = 1.61%
Fe_2O_3 and Al_2O_3	0.59	
Insoluble	0.50	
Organic matter	1.61	
CO_2	42.60	

WATERLOO COUNTY

(104) McCrone Lake, North Dumfries Township

Two small lakes separated by marsh occupy a depression in the southern part of lots 29 and 30, concession VIII, North Dumfries township, Waterloo county. The lakes are visible from county roads 1½ miles east of Ayr, but are only accessible by private road.

In August 1965 marl was exposed in development work around a private dwelling on the southwest side of the smaller, westernmost, lake. W.A. Parks (1903, p.149) mentions marl in the larger lake. The area of the lakes and surrounding marsh is 35 acres, most of which is undoubtedly underlain by marl. Parks (1903, p.149) also mentions marl on the nearby Taylor and Easton farms.

Shells, especially gastropods, are moderately common in marl sampled from the smaller lake. A small amount of brown organic ooze is also present. Dolomite and shale of the Salina Formation is bedrock in the area.

The marl is of only fair quality. A 12-foot section analysed 83.8 percent $CaCO_3$, 3.5 percent $MgCO_3$, 0.25 percent Fe_2O_3, and 1.68 percent insoluble. The dry powder is buff coloured with a moderately low brightness. Oil absorption is high. Natural particle size is 63 percent finer than 325

mesh, 39 percent finer than 10 micron. The crude marl averages 67.3 percent water; 550 pounds of dry marl can be extracted from one cubic yard of the crude.

A section sampled in the marsh at the west end of the smaller lake is shown in Section 43. Results of testwork on sample M56 are given in the Appendix.

Section 43	McCrone Lake	
Depth below water (feet)	Description	Sample No.
0 - 1	Surface vegetation.	
1 - 13	Marl: Pale brown, grading downwards through pale grey to pink-brown; moderately dense; moderate shell content; some fine organic matter near top.	M56
13 +	Rock (bedrock?)	

(105) Roseville, North Dumfries Township

W.A. Parks (1903, p.149) mentions 12 acres of marl adjoining a small pond on lot 31, concession X, North Dumfries township, Waterloo county. According to this description the occurrence should lie just south of interchange 33 on Highway 401, about 2 miles southeast of Roseville.

WELLINGTON COUNTY

(106) Green River, Eramosa Township

G.C. Hoffmann (1894, p.29) mentions ".... a deposit three feet thick, underlying three feet of peat, in the neighbourhood of the Eramosa branch of the Green River, township of Eramosa, Wellington county ...." An analysis of the marl is reproduced in part as follows:

	Percent	
CaO	43.71	Calculated $CaCO_3$ = 78.05%
MgO	0.76	Calculated $MgCO_3$ = 1.59%
Fe_2O_3	0.29	
Insoluble	10.36	
Organic matter	9.79	
CO_2	34.87	

YORK COUNTY

(107) Rouge River, Markham Township

A shallow deposit of marl is mentioned by P.F. Karrow (1967, p.46) on lot 2, concession VIII, Markham township, York county. The deposit in the Rouge valley, ½ mile north of Steeles Avenue on the north side of the CPR, underlies several feet of partly decomposed peat.

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Appendix I | Physical and Chemical Properties of Ontario Marls

Sample Number	M1	M2	M3
Thickness (feet)	9	3	5
Chemical analysis (minus 100-mesh fraction)			
CaO, percent	46.0	48.2	44.4
MgO, percent	1.55	1.82	0.61
Fe_2O_3, percent	0.12	0.11	0.28
Moisture, percent	1.68	1.13	1.86
Loss on ignition, percent	47.79	46.30	49.43
Insoluble, percent	1.92	2.22	3.32
Total	99.1	99.7	99.9
Calculated $CaCO_3$, percent	82.0	86.0	79.2
Calculated $MgCO_3$, percent	3.2	3.8	1.3
Total carbonate	85.2	89.8	80.5
Brightness (relative to mag. carb. standard)	39.5	47.6	41.6
Oil absorption (lbs. oil per 100 lbs. marl)	71.1	53.7	75.7
Moisture (crude marl), percent	70.5	52.9	69.8
Dry marl per cu. yd. of crude, lbs.	490	780	505
Particle size analysis			
Percent finer than 74 micron (200-mesh)	69.0		
" " " 44 micron (325-mesh)	68.0		
" " " 30 micron	65.0		
" " " 20 micron	56.0		
" " " 10 micron	40.5		
" " " 5 micron	28.5		
" " " 2 micron	15.5		
Shells			
(A = common; B = present; C = rare)			
Gastropoda (snails)			
Amnicola	A	C	-
Physa	-	-	B
Planorbis	C	C	A
Graulus	B	C	-
Valvata	-	-	-
Pelecypoda (clams)			
Pisidium	-	-	-
Sphaerium	C	-	-
Ostracoda (ostracods)	B	-	C
Chara (algae)	B	-	-

M4	M5	M6	M7	M8	M9	M10	M11	M12
$4\frac{1}{2}$	7	6	$3\frac{1}{2}$	6	6	5	bulk	4
50.0	47.1	48.0	49.7	46.0	49.4	49.1	49.6	50.4
0.75	0.76	0.86	0.74	1.22	1.41	0.95	0.92	0.83
0.24	0.41	0.24	0.31	0.42	0.26	0.24	0.18	0.11
0.83	1.69	1.79	0.99	1.30	1.15	1.20	0.57	0.62
45.21	46.50	47.46	45.90	45.83	45.84	45.26	44.31	45.83
1.86	2.48	1.24	1.08	3.28	0.56	1.18	3.02	0.56
99.0	99.0	99.6	98.7	98.0	98.6	97.9	98.6	98.4
89.3	84.2	85.6	88.7	82.1	88.0	87.6	88.5	90.0
1.6	1.6	1.8	1.5	2.5	3.0	2.0	1.9	1.7
90.9	85.8	87.4	90.2	84.6	91.0	89.6	90.4	91.7
62.7	53.0	48.0	45.8	43.8	46.2	51.0	56.0	60.0
70.2	77.4	80.0	64.1	63.2	58.5	63.3	56.8	65.8
52.9	67.2	71.6	56.2	63.5	56.6	49.5	38.2	59.8
780	550	475	725	610	720	830	1010	670
89.5		70.5	86.5	76.0	84.0		91.5	82.5
86.5		66.0	83.5	75.0	77.5		89.0	77.0
83.0		62.0	78.0	72.0	70.5		84.5	72.5
79.0		56.5	68.0	65.0	61.5		75.5	66.5
67.5		44.0	43.0	45.5	43.0		54.0	54.0
37.5		28.5	16.0	25.0	23.5		25.5	32.5
12.5		13.0	5.0	9.0	8.5		7.0	13.5
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	C
C	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	B

M13	M14	M15	M16	M17	M18	M19	M20	M21
4	5	7	7	7	5	7½	20	18
49.50	49.28	40.52	6.26	48.42	36.90	48.06	33.38	42.88
1.21	1.25	0.35	1.11	0.18	0.19	1.16	1.99	1.29
0.11	0.24	0.74	1.35	0.15	0.85	0.11	0.33	0.29
0.71	0.94	2.39	0.40	1.52	2.65	1.31	3.63	3.04
46.25	45.76	48.09	4.01	47.20	49.28	46.74	55.24	48.67
0.44	0.56	5.62	86.3	1.20	6.84	0.92	3.54	2.44
98.2	98.0	97.8	99.4	98.7	96.7	98.3	98.1	98.6
88.5	88.0	72.4	11.2	86.3	65.8	85.7	59.5	76.5
2.5	2.6	0.7	2.3	0.4	0.4	2.4	4.2	2.7
91.0	90.6	73.1	13.5	86.7	66.2	88.1	63.7	79.2
52.5	50.0	36.0	31.3	36.6	28.6	44.0	25.0	30.1
78.6	72.2	59.8	19.5	62.4	47.8	61.7	47.2	65.5
61.1	61.2	68.3	23.3	69.6	73.1	64.5	89.6	75.7
645	645	530	1245	510	450	590	180	410
82.5	69.5	78.0	67.0	65.5		80.0	33.5	61.0
79.0	68.0	74.5	41.0	62.0		76.0	32.0	57.5
75.0	65.5	70.0	29.0	58.0		72.0	30.0	53.0
69.0	60.0	64.0	21.0	52.0		66.0	26.5	46.5
54.0	47.0	52.5	11.5	37.5		53.5	19.0	32.0
33.5	28.5	39.0	6.5	26.0		36.5	13.5	22.0
14.5	12.0	22.0	3.0	16.0		15.5	8.5	13.0
-	-	-	-	C	C	-	C	C
C	-	-	-	C	-	-	-	-
B	C	-	-	-	C	C	-	C
-	-	-	-	-	-	B	-	B
-	-	-	-	-	-	-	-	-
-	-	-	-	-	C	B	-	C
-	-	C	-	C	-	-	C	-
-	-	-	-	-	-	C	-	-
-	-	-	-	B	-	C	-	C

M22	M23	M24	M25	M26	M27	M28	M29	M30
19	14	14	10	$7\frac{1}{2}$	14	3	$15\frac{1}{2}$	3
46.74	44.22		48.90	7.26	49.68	47.80	48.78	53.08
1.45	1.35		1.55	1.43	1.70	1.69	0.78	0.85
0.13	0.20	0.50	0.11	1.56	0.11	0.29	0.14	0.06
2.23	1.84		1.19	0.16	1.33	1.59	1.19	0.29
48.01	49.44		46.87	67.14	46.01	46.21	44.72	44.55
0.96	1.84		0.64	22.26	0.72	1.32	2.84	0.20
99.5	98.9		99.26	99.81	99.51	98.90	98.43	99.03
83.5	78.9		87.3	13.0	88.6	85.4	87.0	94.8
3.0	2.8		3.2	3.0	3.6	3.5	1.6	1.8
86.5	81.7		90.5	16.0	92.2	88.9	88.6	96.6
35.5	35.7	15.1	48.5	12.0	48.2	39.8	45.9	73.0
65.6	71.1	61.8	78.7	25.2	70.4	75.7	60.2	37.0
69.4	72.2	92.4	68.6	92.9	62.7	55.4	63.8	84.6
510	465	130	525	125	620	735	605	265
74.5		76.5	80.5		90.0		77.0	92.5
68.5		72.0	79.0		89.0		69.5	91.0
62.5		67.0	75.0		86.5		61.5	87.5
54.5		60.0	68.0		80.5		52.0	82.0
37.5		43.5	55.0		67.5		33.5	68.5
22.0		30.0	38.0		51.0		18.0	44.5
9.0		16.5	19.0		29.5		7.5	15.5
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	B	-
C	-	-	C	-	C	B	C	-
C	B	B	B	-	C	B	-	-
-	-	-	-	-	-	-	-	-
C	-	-	-	C	B	-	-	-
-	C	-	C	B	B	-	-	-
-	-	-	-	-	-	-	-	-
C	C	-	B	-	A	-	B	A

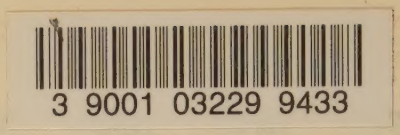
M31	M32	M33	M34	M35	M36	M37	M38	M39
$7\frac{1}{2}$	7	9	5	6	18	$4\frac{1}{2}$	10	4
51.32	51.20	51.50	49.88	48.88	51.96	48.68	51.72	51.84
1.06	0.86	1.18	1.09	1.40	0.65	0.63	0.58	0.86
0.07	0.05	0.04	0.10	0.12	0.05	0.15	0.11	0.07
0.77	1.10	0.73	0.78	0.95	1.76	1.69	1.04	0.91
46.02	45.73	45.47	45.55	46.72	45.00	46.25	45.65	45.12
0.46	0.16	0.20	0.92	1.20	0.34	0.84	0.46	0.61
99.70	99.09	99.03	98.32	99.27	99.76	99.34	99.56	99.40
91.6	91.5	92.0	89.0	87.3	92.6	87.0	92.4	92.5
2.2	1.8	2.5	2.3	2.9	1.4	1.3	1.2	1.8
93.8	93.3	94.5	91.3	90.2	94.0	88.3	93.6	94.3
58.7	55.0	61.4	55.1	50.4	46.2	39.6	44.5	50.2
62.5	56.1	60.5	64.0	64.9	70.7	65.7	59.3	52.9
49.9	54.6	52.6	52.8	57.2	63.5	56.8	51.3	50.6
825	750	785	780	710	610	715	800	810
94.0	84.0	88.0	83.0	89.0	84.0	81.5	83.5	
93.0	81.0	86.0	81.5	85.0	79.0	78.5	78.0	
90.5	77.0	82.5	78.5	80.5	74.5	74.5	73.0	
85.0	71.5	77.0	72.5	74.5	70.0	69.0	66.5	
65.5	58.0	62.0	58.0	61.0	61.0	55.0	56.0	
38.0	40.5	38.0	37.0	36.5	52.0	41.0	43.5	
14.5	22.0	15.5	14.0	14.5	37.0	27.0	26.5	
-	-	-	-	-	C	-	-	-
-	-	-	-	C	-	-	-	-
C	B	A	C	B	-	-	C	C
-	-	-	-	C	-	B	-	-
-	-	-	C	-	B	C	-	C
-	-	-	-	-	C	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
B	A	B	B	B	A	B	A	B

M40	M41	M42	M43	M44	M45	M46	M47	M48
4	5	10	7	10	3	11	6	$7\frac{1}{2}$
50.08	48.78	46.00	45.14	45.36	47.14	46.56	35.62	47.10
0.63	1.39	1.30	1.61	1.61	1.69	1.71	1.66	1.66
0.33	0.34	0.34	0.36	0.30	0.46	0.20	1.03	0.24
1.51	0.90	2.11	1.59	1.66	1.02	1.21	2.66	0.76
45.91	45.68	45.76	46.41	47.73	46.00	47.58	43.89	45.42
1.00	1.96	2.96	3.30	3.06	2.98	1.82	12.64	2.20
99.46	99.05	98.47	98.41	99.72	99.47	99.08	97.48	97.38
89.4	87.0	82.0	80.5	80.9	84.1	83.2	64.6	84.0
1.3	2.9	2.7	3.4	3.4	3.5	3.6	3.5	3.5
90.7	89.9	84.7	83.9	84.3	87.6	86.8	68.1	87.5
42.2	51.2	30.9	41.0	37.5	47.2	45.2	31.0	52.9
63.4	57.0	59.0	71.2	68.3	67.2	66.6	62.9	59.2
50.4	47.3	76.5	69.1	70.0	53.6	68.0	75.2	60.2
815	870	400	515	500	770	535	420	660
	87.0	48.5	76.5	56.5	87.0	69.5		87.5
	84.5	44.0	74.0	53.5	85.0	69.0		84.5
	81.0	40.5	70.5	50.0	81.5	66.0		80.5
	76.0	36.0	65.0	44.0	76.0	60.0		75.0
	62.5	25.0	50.0	31.0	64.5	45.5		63.0
	40.0	17.0	33.0	20.0	51.0	33.0		45.0
	19.5	11.0	17.5	11.0	33.5	20.0		25.0
-	C	B	-	-	-	B	-	C
-	-	-	-	-	-	-	-	-
-	-	B	B	B	-	A	-	C
-	C	-	-	-	-	-	A	A
-	C	B	-	-	C	B	-	B
-	C	B	B	B	B	B	-	A
-	-	-	-	-	C	-	-	-
-	-	-	-	-	-	-	-	-
B	B	C	C	-	C	C	-	B

M49	M50	M51	M52	M53	M54	M55	M56	M57
bulk	9	6	7	7	2	3	12	$5\frac{1}{2}$
46.12	50.66	50.04	49.90	49.04	50.52	50.46	46.90	53.52
0.58	0.77	1.16	1.14	1.51	1.58	1.67	1.67	0.37
0.34	0.06	0.09	0.11	0.21	0.49	0.11	0.25	0.07
1.42	0.85	0.78	0.95	0.90	0.68	0.58	1.16	0.41
43.56	45.25	44.93	45.69	45.75	44.30	45.51	47.00	44.50
5.44	0.52	1.08	0.76	1.20	0.82	1.82	1.68	0.32
97.46	98.11	98.08	98.55	98.61	98.40	100.15	98.59	99.19
82.4	90.5	89.5	89.0	87.5	90.3	90.0	83.8	95.5
1.2	1.6	2.4	2.4	3.2	3.3	3.5	3.5	0.8
83.6	92.1	91.9	91.4	90.7	93.6	93.5	87.3	96.3
51.5	60.1	60.5	54.5	52.0	56.3	51.4	48.8	72.2
56.4	57.1	64.8	64.4	70.9	56.0	44.5	74.2	36.6
	62.8	59.6	61.1	60.1	53.6	45.0	67.3	42.5
	620	670	645	660	770	900	550	945
81.0	77.5	85.5	86.0	85.5	85.5	85.5	69.5	87.0
74.0	74.0	83.5	85.0	84.0	81.5	69.0	63.5	82.0
67.5	70.0	81.0	82.0	81.5	76.5	57.5	58.5	77.0
59.5	65.0	75.5	76.5	76.0	69.0	47.5	52.0	70.5
43.0	52.5	62.0	62.5	63.0	48.0	33.0	39.0	56.0
28.5	36.0	45.0	44.0	46.5	24.5	20.0	26.0	37.0
15.0	18.0	25.5	21.0	23.0	10.5	11.0	15.5	17.5
B	B	B	B	B	B	B	C	B
-	B	B	C	-	-	-	C	-
B	B	C	C	A	-	B	C	-
B	A	B	C	B	B	B	A	B
C	A	B	B	B	-	-	A	-
B	-	-	B	C	B	B	-	C
-	-	-	-	-	-	-	-	-
-	-	-	C	-	B	-	-	-
B	A	A	A	C	A	A	B	A

M58	M59	M60	M61	M62	M63	M64	M65	M66
10	13	5	13	1½	8½	7	8½	8
51.42	52.00	49.28	50.34	53.06	48.36	49.44	47.88	52.94
0.69	0.51	0.52	0.53	0.73	1.03	0.74	0.93	1.20
0.10	0.07	0.21	0.09	0.08	0.11	0.09	0.11	0.11
0.66	0.67	1.00	1.15	0.26	0.98	1.20	1.21	0.68
44.61	45.62	46.10	47.07	44.14	46.38	45.96	46.84	45.88
1.90	0.28	1.68	0.58	0.46	0.84	0.90	1.24	0.66
99.38	99.15	98.79	99.76	98.73	97.70	98.33	98.21	101.47
91.7	92.8	88.0	89.9	94.9	88.4	89.6	87.4	94.0
1.4	1.1	1.1	1.1	1.5	2.2	1.5	1.9	2.5
93.1	93.9	89.1	91.0	96.4	90.6	91.1	89.3	96.5
52.6	54.0	44.9	45.0	79.1	43.8	52.1	42.5	47.8
61.6	67.0	75.9	83.5	40.8	69.5	68.3	81.4	65.4
57.8	51.5		72.4	2.9	65.8		66.9	63.6
700	800		465		570		550	610
86.0	71.5		59.0	95.0	72.0		85.5	84.5
81.5	65.0		50.0	94.0	70.5		85.0	81.5
76.0	60.5		44.0	91.5	67.0		83.0	78.0
67.0	55.0		37.5	87.0	60.0		77.5	72.5
40.0	45.0		27.5	75.0	48.0		64.5	57.5
20.5	33.0		18.5	51.5	33.0		46.0	43.0
10.0	22.5		12.0	23.0	19.0		22.5	26.5
-	C	B	B	C	B	B	A	B
-	B	C	-	-	C	C	B	B
-	C	B	-	-	C	B	C	C
B	C	B	A	A	-	C	B	-
C	B	B	B	B	B	C	B	B
C	B	C	B	B	B	A	C	A
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
B	A	-	C	A	B	B	B	B

M67	M68	M69	M70	M71	M72	M73
7	4	8	2	$7\frac{1}{2}$	9	bulk
49.20	46.88	45.24	17.50	34.96	45.40	47.84
0.92	1.41	1.55	7.25	5.12	0.43	1.12
0.20	0.44	0.10	2.14	0.69	0.43	0.32
0.87	1.24	0.82	0.71	0.42	2.00	0.70
46.73	46.58	49.06	19.61	30.90	46.39	45.28
0.58	1.24	1.36	51.16	28.76	4.32	2.26
98.50	100.23	98.13	98.34	100.85	98.97	97.52
89.9	86.6	83.8	36.3	63.1	81.9	85.5
1.9	3.0	3.2	15.1	10.7	0.9	2.3
91.8	89.6	87.0	51.4	73.8	82.8	87.8
47.8	47.0	50.1	44.7	48.4	36.1	45.0
70.3	76.7	69.7	26.4	40.5	62.6	71.0
63.4	79.1	66.3	28.6	43.0	77.3	44.5
610	350	560	1165	935	380	910
82.5	66.0	84.0	98.5	72.0	56.5	85.0
81.5	65.0	82.5	95.0	69.5	54.0	79.5
78.5	63.5	80.0	90.0	65.0	50.0	74.5
73.0	59.5	74.5	80.0	58.5	45.0	69.0
59.0	50.0	60.0	51.0	43.0	34.5	58.0
41.0	39.0	42.0	33.5	28.5	23.0	43.5
24.5	24.0	23.0	22.0	14.0	14.5	29.0
C	-	C	-	C	C	B
C	-	-	-	-	C	-
C	C	C	-	-	C	C
B	A	C	-	B	-	C
A	B	-	-	-	A	B
B	C	C	C	B	B	B
-	-	-	-	-	B	-
-	-	-	-	-	-	-
B	-	C	C	-	-	A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